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THE UNIVERSITY OF ALBERTA

STUDENT PERCEPTIONS OF THEIR JUNIOR HIGH SCHOOL SCIENCE EXPERIENCE

by

Norman Robert Gilberstad

A THESIS
SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH
IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE
OF MASTER OF EDUCATION

DEPARTMENT OF SECONDARY EDUCATION

EDMONTON, ALBERTA
FALL, 1986

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled "Student perceptions of their junior high school science experience", submitted by Norman Robert Gilberstad in partial fulfilment of the requirements for the degree of Master of Education in Secondary Education.

Supervisor

K. G. Jacknicke

John Osborne

Date May 26, 1986

DEDICATION

To my parents who encouraged me to reach higher.

ABSTRACT

There is no reason to suppose that students experience their science education, or perceive the totality of that experience, in precisely the same way. Yet, themes or forms common to many students may be identified that depict part of the students' life-world. The thrust of the present inquiry is to reveal what it means to be a junior high science student. By intersubjectively exploring student perceptions of what life is like for them in the science classroom, two epistemological issues are addressed: (1) what students like about school science and (2) how students view science instruction.

Four junior high science classes from one urban public school afforded the researcher the opportunity to interact directly with students, their teacher and the classroom setting. Twelve students and their teacher, Mr. T, were interviewed recurrently within a one year period. Individual interviews were supplemented by audiotaped lessons, observer notes and students' written descriptions. Transcripts of passages from one day's lesson served as a focus for a structured interview the following day. Through follow up interviews, the researcher sought to explore the rootedness of the initial student descriptions, explanations and interpretations.

Analysis suggests that students like their school science experience and see it differently from those of other classes. As the principal focus for student perceptions, the teacher is seen as an effective communicator, providing lab activities and permitting a degree of movement and social interaction. A deeper level of analysis reveals underlying motives for themes such as "boring", "interesting", "understanding", "frustrating" and "work."

An ontological analysis of the school science experience hypothesizes that students live a duality. Students seem to share a contrasting frame of reference in which their "shared" experience is lived not only in superficial terms such as "boring vs. understanding" or "interesting vs. work" but, also, in a more fundamental sense. This dialectical thinking suggests a conflict students face when, desirous of what they consider to be meaningful activity they are, instead, recipients of what they judge to be meaningless activity. Perceived teacher affirmation of the student may be one means by which student indifference and resistance is obviated.

The thesis speaks for students, saying that: we must not be taken for granted; we acknowledge and support the

teacher's authority and responsibility for creating the environment in which we must live; we anticipate and expect recognition; we will seek to learn teacher meanings when there is prior teacher affirmation of our individualities; we may choose not to learn because of the less than positive way we perceive our experiences. It suggests that educators must strive for openness through two-way communication in their teaching.

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CHAPTER I

INTRODUCTION AND BACKGROUND TO THE STUDY

Search for the Question

Choosing a research topic was difficult and problematic. The reading of Oldham's (1982) thesis on the nature of difficulty as experienced by senior high school biology students in their study of biology, and her notion of difficulty as a mode of being, prompted my self-reflection on the difficulty my former students and I had experienced. This reflection led me initially to consider "student perception of teacher instructions" and "reciprocity of perspectives" as possible research topics. More specifically, the teacher expression, "think about it", intrigued me as a possible source of misinterpretation and, thus, a suitable focus for research.

It seemed to me that when teachers use expressions such as "think about it" in some context, they are taking for granted that each student will elicit the same meaning(s). I could not ignore the possibility that for many science teachers' instructions, there might be frequent student misinterpretation that would account for some of the difficulty students experience.

Three factors helped redirect my attention toward what have become the present research questions: "how students perceive their school science experience" and "what it means to be a science student." First, in two of my graduate seminars, I was introduced to phenomenology and hermeneutics that excited me as research paradigms. Second, I had been favorably impressed both by some recently completed naturalistic studies in education and by the reactions of colleagues doing qualitative research. Third, in both my pilot study and data collection procedures, the teachers observed did not use the expression, "think about it." Rather, they used various "think" expressions such as: "I think the gas is hydrogen", "you should think -- about 20 minutes each" and "what do you think the ratio is?" It quickly became apparent that I would not be able to survey science students from grades eight and nine regarding a teacher's use of a single expression in a similar, if not identical, context.

I next sought to define the context for the question, how do students perceive their school science experience? I formulated three questions that could be subsumed under this umbrella question: what do students like about science, how do students perceive science instruction, and how do students feel about the physical environment in which they learn science. I then used these to modify the pilot interview guide and help structure the guide's final form.

Reflection upon my career as a teacher of adolescents provided me with added incentive and support for my decision to engage students for this study. I recalled what I perceived to have been my caring and sensitive attitude toward students' needs and how often this seemed to conflict with pressures imposed by the prescribed curriculum. I recalled, too, what it was that I did and did not do that made a difference to the science classroom experience. In my self-reflection I also sensed that student comments such as: "he's a good teacher", "that was an exciting class", and "what a boring period", seemed to be a function of _my_ enthusiasm, _my_ preparation and organization, _my_ communication skills, and _my_ personal interest in the subject matter, methodology and _students_.

I felt it was I, as teacher, who created the opportunity for students to turn off: to lose interest, to become bored, to see things as unimportant, to find content difficult and hard to understand. I recalled having been instructed on what constituted an effective learning environment. I had been aware of research that brought forth the adult perspective and sought to base its assumptions of what effective teaching and learning were, on adult perspectives of student behavior and performance. In a recent instance, the 1983, Science Council of Canada's published assessment of the status of science education in this country took into account perspectives of educators while overlooking the student perspective of science education.

Focus of the Study

In the context of the junior high school science classroom, this thesis represents an attempt to see the student perspective of school science. It seeks to portray the lived-experience of the science student as seen through the student's eyes and to contemplate what it means to be a science student.

The focus of this study is an exploration of student and teacher perceptions of their school science experience. The attempt is made to identify common themes that characterize the experience for a majority of students. An effort is then made to understand student perceptions in light of teacher perceptions, the lived-experience of adolescence, and the process of socialization.

Review of the Literature

The science education literature surveyed relates both directly and indirectly to science students of intermediate and high school age. It reports not only research findings but, also, educational thinking that is grounded in research. While keeping the student in focus, the review is organized under four categories that serve to identify major approaches towards understanding schooling and learning: science curricula as practised, student-teacher interaction within the classroom, student perspectives on school science, and teacher perspectives on teaching.

It is clear that surveys have been the principal technique used to record the beliefs, opinions and attitudes of science students. Where researchers have used interviews and observations, studies have focused on a school or grade population rather than on students in a particular discipline. As a result, much is known about student behavior and preferences; what they like and do not like. Considerably less is known about student reasons for their likes and dislikes.

Science Curricula as Practised

The National Science Foundation studies of the late 1970's state that teachers are the ones who direct science instruction (Hofwolt, 1985). Thus, in terms of the decision-making process, teachers control the learning environment. While teachers participate in textbook selection many, nonetheless, permit the text to dictate course content, instuction mode and the nature of evaluation. Evidence for this lies in widespread textbook adoption practices by school districts, pressures from back-to-basics advocates and lobbyists, and the widespread use of standardized tests in American schools although many of the test questions bear little relationship to textbook content.

Yager (1983) reported that most science teachers stress in their teaching the preparation of students for further study in school science. As a framework and focus for their courses, teachers use the reconstructed knowledge of the science textbook. Apple, in Giroux (1985, p. 25), remarked that in many school texts "knowledge is broken down into discrete parts, [and is] standardized for easier consumption." He earlier argued (1982) that prepackaged curricula encourage teachers to do little more than effect predetermined content and instructional procedures.

Using lecture, and question and answer techniques, teachers convey information through the language of the textbook. Thus, in school science, many teachers emphasize "unchanging" content while ignoring or neglecting process. There does not appear to be much direct teaching of problem solving, inquiry and higher intellectual skills. This knowledge likely imparts a world view of science different from what would be achieved were science being learned through direct, "hands-on" experience.

In North American schools, science education is associated with student passivity. Students tend not to assume responsibility for their own learning but, rather, wait to be taught (Welch, 1985). This observation supports Cusick's (1973) earlier claim that curricular programs, as practised, impart "a doctrine of adolescent inferiority, which denies students' initiative and responsibility (p. 208)." For the most part, as Goodlad (1984) found, students are required only to possess information and are only rarely encouraged to explore and apply it or to understand the implications of that information.

With respect to instructional arrangements, studies suggest that students carry out individual assignments about 30% of the time and participate in small groups about 15% of the time. Teachers use the demonstration at least once a week in about 40% of the classes observed which is much more frequent than they provide lab experiences. Only occasionally do they provide students with opportunities to manipulate materials or to plan activities that interest them. Moreover, Goodlad (1984) claimed that students seldom participate with classmates in setting their own goals for projects.

The main method of teaching is recitation. Students look up information; recite or record it. They learn to follow directions and to verify information through workbook exercises. Rarely do students engage in activities for which answers are not already available. Goodlad (1984) states that in only about half the science classes are students able to do projects or reports, once a month on average. He writes:

> Only rarely did we find evidence to suggest instruction likely to go much beyond mere possession of information to a level of understanding its implications and either applying it or exploring its possible applications. . . . And it appears that this preoccupation with the lower intellectual processes pervades . . . science as well. . . . One finds little of activities likely to promote

> an understanding of the basic interdependence of the biological and physical resources of the environment. (p. 236)

Indeed, little learning is seen to be organized almost exclusively around observations of things outside schools complete with follow up reading, writing and dialogue.

Insofar as commonly stated goals of the high school curriculum are concerned, Goodlad's (1984) observations suggest a "formidable gap" between teacher-stated expectations and actual teaching practice. For example, critical thinking often appears along side of aspects of scientific method as a goal to be achieved through curriculum-as-practised. Yet, Goodlad stated that he "could not readily see how the intellectual behavior mentioned [,namely, scientific and critical thinking,] was to be developed via the topics [teachers] listed (p. 216)." This connection could not be established based upon researcher observation, teacher reporting or testing practice.

Kyle (1985) argued that teachers are key in developing and maintaining exemplary science programs with environments conducive to inquiry.

> These teachers are included in developing curricula for their grade/course; they do not have a textbook-oriented program; they

> integrate more laboratory investigations and spend less time lecturing than teachers in general . . . .
>
> They . . . have high expectations of themselves; they provide a stimulating environment and an accepting atmosphere, while encouraging student action, decision-making, creativity and excitement. They challenge students, expect different students to achieve differently, and develop effective communication skills, all while stressing the development of higher intellectual skills. (p. 126)

In schools where students demonstrate high levels of scholastic achievement, teachers receive strong admininstrative support. These teachers seek support from additional sources such as parents and leaders from the community, business and industry.

Student-Teacher Interaction

> The basic and crucial element in classroom life is the quality of the personal relationship between the teacher and each individual student. The respondents in our study are so acutely conscious of the teacher as a person that there can be little question that this consciousness persistently and intrusively determines the student's perceptions of the class, his attitude toward science, and to some extent . . . his achievement in science (my emphasis). (Cooper & Petrosky, 1974, p. 26)

Okey and Butts (1982) cited research by Brown and MacDougall who claimed that interpersonal relationships are key to the establishment of an effective learning climate. One such relationship is student-teacher rapport. Okey and Butts concluded from their review of the literature that it is possible to "nurture positive student behavior and learning outcomes" through rapport. Specific aspects of rapport could include "true two-way communication with students", expression of student feelings, listening and accepting students, avoidance of criticism, reinforcement from peers and the teacher, corrective feedback, praise and positive motivation. According to Butts and Hord as cited by Okey and Butts, an important element of two-way communication among classroom members is the freedom to express feelings.

Goodlad (1984) speculated that "high or low levels of satisfaction may be quite powerful indicators of the quality of the relationship between teachers and students in classrooms (p. 247)." House and Lapan, in Fullan (1982), identified five major factors that "make teachers credible in the eyes of students." These include the teachers' demonstrated: (1) willingness to accept suggestions; (2) encouragement for students to express ideas, likes and dislikes regarding curriculum and classroom practices; (3) clarity in stating expectations for students; (4) knowledge of the subject and expertise; (5) ability to communicate effectively; and (6) ability to fairly and objectively evaluate student performance. In terms of his own research, Fullan (1982) concluded that most students do not perceive these characteristics in most student-teacher relationships. The absence of some of these characteristics is reflected in Goodlad's (1984) comment that "teacher[s] rarely responded in turn directly to . . . [a student] response with supportive language, corrective feedback, or some other meaningful acknowledgement (p. 229)." Instead they tend to make nondirected, nonpersonal responses. Student-initiated questions and ideas are rarely observed and reported.

Goodlad (1984) characterized the teacher-students relationship as passive and sterile,

> almost devoid of outward evidences of affect. Shared laughter, overt enthusiam, or angry outbursts were rarely observed. Less than 3% of classroom time was devoted to praise, abrasive comments, expressions of joy or humor. (pp. 229-230)

In sum, Goodlad (1984) suggested that high school students do not relate strongly to their teachers "even on academic matters." Teachers tend not to relate to personal concerns of students.

The Student Perspective

It is generally believed that as students begin new science classes, they enter with a bias towards science based upon past school science experience and influenced by parental attitudes and media. Specific feelings may vary from "can't wait to carry out experiments" to "don't like science." Simpson (1978) suggested that student feelings, in reality, are complex and stem primarily from past successes and failures.

Yager and Penick (1984) reported that a majority of students believe that not only are the things they learn in science "dull" and "no fun" but, also, have "little relevance to the real world." Rowe (1977) suggested that what is relevant to adolescents surrounds a series of implicit questions such as: What values control activities? Where do I fit in? What difference can I make? Do I care? Does anybody care? Koballa (1985, p. 34) pointed out that "much adolescent behavior can be understood with reference to this search for meaning." When the curricular focus in science doesn't address this issue, students may be driven away from electing further science courses.

Students may elect to resist when their personal needs are not addressed in compulsory science courses (Everhart, 1983). Koballa suggested that students must understand how science is related to personal and societal problems. They must be given opportunities to learn appropriate methods of problem solving.

In his review of the research, Hofwolt (1985) reported that student perspectives of their role in determining instructional practices are consistent with observations of Stake and Easley (1978), Welch (1981) and others. Most students feel that, in the main, the teacher determines course content with students having little or no input. They feel that the textbook provides the structure and organization most of the time. Most students also feel they have no choice in the way they learn; the teacher determines the nature of the science studied, the order of topics, test schedules and assignment due dates. By and large they are not even aware of instructional objectives. Students believe that teachers value student ability to think for themselves. However, few teachers deliberately teach the development of higher cognitive skills in their students. Students do not perceive their teachers taking a personal interest in them in this regard. Students are split as to whether or not their teachers encourage them to state their own opinions and to be creative. About half of them feel that their teacher either seldom or never admits not knowing "everything" related to a topic. In conclusion, Hofwolt stated,

> there is little student satisfaction with science classes. Students generally see science as . . . a place where they do not wish to be. Students do not like the typical or traditional science classroom. (p. 45)

In his review of "where students are at", Fullan (1982) confidently stated that "students are not treated in schools as people whose opinions matter . . . . As students move from elementary through secondary grade levels they become increasingly bored and alienated from school (p. 154)." It is, thus, highly probable that students' perspectives of their experiences in school science are influenced by global school factors such as satisfactory social relationships, teaching styles of their teachers and their academic orientation.

Research data from studies of junior high school students support the belief that many of these students derive their satisfaction from "their perceived success in peer-group relationships and not from characteristics of schools as such (Goodlad, 1984, p. 254)." Moreover, it appears that these students are more concerned over non-academic problems than are their teachers. Students must see an area of their lives, such as the school or classroom, sufficiently interesting and enjoyable to begin identifying with it. Goodlad writes:

> Whether or not they (students) perceive themselves to be good looking and popular overrides most other considerations both in and out of school. . . . Satisfaction in school has to do with peer-group relations and personal perceptions of social relationships. (p. 254)

Goodlad (1984) reported that students, irrespective of subject, prefer "hands-on" activities and ones involving collaboration. The latter is consistent with their preoccupation with interests centering on the peer group. It may be that active involvement is more consistent with the Piagetian concrete operational period of development. It may also be that young adolescents derive a sense of ownership from that involvement.

In summarizing research done in the late 1970s, Goodlad (1984) found that about 66% of students like science and nearly 80% think science important. Less than a third of science students say they like working alone or as a total class. Similar numbers of students report liking worksheets and textbooks or listening to the teacher. Thus, for the most common activities and instructional materials used in science classes, only a minority of students indicate liking them "very much." The apparent emphasis on these activities may well contribute to a classroom tone and routine that junior high school students in the main find "flat" and boring. Goodlad concluded that "many little things add up to a classroom climate perceived by students to be more or less satisfying (p. 248)."

Lawrenz' (1976) research reported that student satisfaction is positively correlated with clearly stated goals and student involvement in class decisions. It is negatively correlated with teacher favoritism, disorganized teaching and friction among students. It seems that general patterns of classroom organization are central in determining student attitudes toward school science.

In their review of the literature, McMillan and May (1979) found that, for the most part, teacher-related variables such as personality characteristics and classroom climate are most important to the development of student attitudes toward school science. They then researched the most important factors in students liking or not liking science and found preferences for active involvement and experience in the learning process. Students also indicate that the teacher's personality and interrelationship with students are crucial to the development of positive attitudes toward science.

While teachers may be viewed as central to classroom life, students rarely see them as the most satisfying aspect of the school experience. Nonetheless, Goodlad (1984) claimed that when students perceived their teachers' interest in them as persons, their level of satisfaction with the classroom experience is significantly higher than it might otherwise be. Parents encountered in the research studies confirm that their children want "to be known as persons as well as students."

Support for Goodlad's (1984) claim may be found in Simpson's (1978) survey of research linking teacher characteristics with student feelings toward school science. He cited research that suggests students preferred "teachers who made them feel good about themselves" and who care about their feelings. Rowe (1977) reported interview data in which students express a willingness to work harder for such teachers. They even went so far as to suggest that they "generally got higher grades when they sensed teacher caring (p. 37)." Two secondary school students offered their perspective:

> Attention is important to all students. A teacher should give equal time to all students . . . . As students, we feel that a teacher is obliged (to a certain point) to take an honest interest in each individual student. Knowing and understanding a student makes teaching that student easier. (Moore & Kocan, 1983, p. 173)

Simpson (1978) thinks that Benjamin Bloom's findings reflect the importance of what teachers communicate to students in the development of student self concepts. Simpson hypothesized that student feelings toward self might rate as more important than feelings toward science and school.

Eastridge (1976) offered a different perspective based upon findings by McKeachie, Lin and Mann and their interpretion. These researchers suggested that "personal liking" of the teacher by a student is a questionable factor in bringing about an effective learning relationship. They claimed that in some cases students have a greater need for qualities other than teacher "affiliation" such as greater structure. The implication here for better instruction is to focus on curricular objectives.

Simpson (1978) also reported the separate, though related, theoretical work of Carkhuff (1969) and Gazda (1973) who developed models to explain the "progressive development of effective human relations." Gazda suggested that students must be convinced of a teacher's empathy as a first step before accepting help from that teacher. The teacher must also communicate respect, warmth and concreteness. Simpson concluded that

> unless teachers can get in touch with students' feelings, and communicate to students their understanding and concern, proper relationships will not develop, and student needs will not be met in the classroom. . . . The teacher stands at the center . . . [and] is probably the most important factor in influencing the minds and feelings of students toward science. (p. 48, 51)

Benson (1984) offered another perspective of the student-teacher relationship from his study of senior biology students. He suggested that students perceive themselves to be intellectually independent of their teacher for their conceptions of biology and biological knowledge until they are confronted by questions that cause them to reflect on those conceptions and knowledge. Benson underscores the importance of the teacher to student perceptions of school biology when he concluded, "Students perceive their purpose as learning particular points of a teacher's conceptions (p. 222)."

In sum, Simpson (1978) describes the classroom environment as a composite of four elements: the way students and teachers interact; the feelings exchanged between students and teachers; teaching methods; and management techniques. "The feelings students have toward this environment, toward their teachers, and toward major classroom events represent a screen through which intellectual activities are filtered (p. 41)."

The Teacher Perspective

Stake and Easley (1978) concluded that teacher action in the science classroom did not reflect the decision-making power available to them. These researchers reported that teachers feel they have little power to change things over which they have some measure of control. Teachers believe there is little more that they can effect without outside support. Because teachers feel "handcuffed", they appear resigned to unchanging educational practices.

Teachers' doubts about having a "common technical culture" could contribute to feelings of non-support and powerlessness. Lortie (1975) writes, "cellular organization retards rather than enhances colleagueship (p. 56)." Norms exist where teachers do not share, observe and discuss each other's teaching. This may mean that teachers, for the most part, deal privately with their concerns about the status quo. They do not share a "viable, generalized body of knowledge and practice (p. 79)."

Lortie (1975) researched and discussed at length the personal purposes of teachers. He argued that it is possible to interpret their beliefs, goals and actions in terms of classroom instruction. He stated that teachers "want to produce 'good' people -- students who like learning -- and they hope they will attain such goals with all their students (p. 132)." Lortie further suggested that teachers seek a "high level of personal impact . . . [They] must change moral or emotional attitudes or permeate the consciousness of every student (p. 116)." The latter may be thought of as the "means" to an instructional "end."

While Goodlad (1984) concurs that teachers want to teach he also indicated that their satisfaction at the junior high school level may be influenced by "characteristics of students' personal and social lives at school." He reported that what students see as primary concerns, their teachers view as "dissonance in conducting school and classroom business." He concluded

> young humans come to be viewed only as students valued primarily for their academic aptitude and industry rather than as individual persons preoccupied with the physical, social, and personal needs unique to their circumstances and stage in life (my emphasis)." (p. 80)

As such, the teacher's role is "a far cry from nurturing students in the personal and social nonacademic aspects of their lives in school (p. 89)."

The Researcher's Position

Typical of much of the research reported in the literature is the paucity of in-depth information concerning student perspectives (and, perhaps, teacher perspectives) on school science. In large measure, the literature surveyed portrays adult interpretations and meanings - an adult perspective based largely on observation of student behavior and on survey questions reflecting predetermined adult-formulated categories.

The researcher believes that to balance the existing perspective it is necessary, as much as possible, to reveal the student's cognitive and affective view of the school science experience. Using emergent themes gleaned from interview data and observational notes, the researcher seeks to "paint a portrait" of how junior high school students perceive their school science experience. He tries using student interpretations to illuminate student-held meanings. To the degree that this is possible, the researcher can probe a deeper level of understanding: what it means to be a junior high school science student.

CHAPTER II

METHOD

This chapter describes the design of the study and the procedures used to (1) develop the instruments, (2) obtain the sample of students and teacher, (3) administer the instruments, and (4) analyze the data.

Research Design

The main purpose of this qualitative study is to understand the student-science relationship in the setting of the science classroom. The researcher seeks this understanding through perceptions provided by 6, eighth grade and 8, ninth grade students and their science teacher. These perceptions are described in Chapter III. They are then analyzed and explained in Chapter IV.

An important limitation in the design of this study is that it does not, and can not, take student and teacher history into account. By entering the setting late in the term and by not 'participating' with students in their 'lived-experience', the researcher is not able to get a clear sense of how their perceptions develop. While this question is outside the context for this study, it remains a significant issue.

Instrumentation

Interview Guides

The researcher conducted semi-structured, audiotaped interviews with students and teacher. The same interview guide was used with all students (see Appendix A) to provide consistency from student to student. Questions were chosen appropriate to the initial purpose of the study: the gathering of student perceptions of their experiences in the science classroom.

The researcher's choice of questions allowed for open-ended discussion and exploration of issues. Each question was designed to elicit reasons; to get at underlying motivation as it related to students' perceptions. The initial question was formulated around transcribed teacher talk from the previous day's lesson, one that included a teacher instruction for students (see Appendix B for one of the transcriptions used). This provided a concrete referent by which to begin each interview.

The teacher interview was modeled after the student interviews. The original teacher (Mr. T) interview schedule (see Appendix C) was modified to allow teacher comment on some issues raised by students. A principal focus for the teacher interview was to gather perspectives on how the teacher viewed the school science experience. These perspectives provided a basis for comparison with student perceptions. The researcher also sought Mr. T's perceptions of his objectives (intents) for his students and for the subject of science as he taught it. The teacher's comments provided perceptual checks against researcher observations of classroom activity.

Observations

The researcher observed eight lessons, six of which were audiotaped. Descriptive notes were taken with regard to the following: general student demeanor while entering and leaving the classroom, and before, during and after lessons; lesson organization; teacher-student dialogue; teacher language; how Mr. T presented himself to students and where he physically positioned himself with respect to students; seating arrangements; locations in the room where activities took place; resource materials used; and evaluation procedures.

The researcher observed and recorded handwritten notes of Mr. T's interaction with students before and after the formal lesson, and during the lunch hour. The researcher recorded a physical description of the classroom and its major contents.

Pilot

The researcher piloted the student interview guide with two grade ten girls attending a large urban high school. One purpose of the piloting was to help identify ambiguities in questions. From the girls' responses the researcher was able to judge how well the intent of a question was communicated. These students also gave the researcher their opinions as to the appropriateness of the questions for students of grades eight and nine. Based upon the piloting the researcher made small changes in the wording of two questions and chose to delete one question.

The procedure of selecting a transcripted piece of teacher dialogue and presenting it to students of that class the next day was tested on three grade ten students from the same high school. The purpose of this procedure was to validate the technique as one that could serve to focus student and teacher interviews in the main study. The researcher was satisfied that students recognized the brief passage and the context of the lesson from which the excerpt was taken. The researcher determined that these students were able to suggest meanings for a specific part of the transcription.

Sample

The choice of school and teacher came about by way of a conversation the researcher had with a colleague at the University of Alberta. The colleague suggested her former science teacher whom she felt would be willing to participate. The researcher approached Mr. T who agreed to participate. Mr. T teaches at a junior high, public school in an urban setting.

At the outset, the researcher felt that the teacher should be part of the study for two reasons. First, the teacher is part of the student's school and classroom environment. Holt (1983), Kohl (1967), Lortie (1975) and others unequivocally remind us that the teacher is part of student experience. Second, an initial focus for this research was to examine both reciprocity of perspectives for student and teacher and the degree of shared meanings. As data collection proceeded, the researcher became acutely aware that students view their classroom science experience in terms of their teacher. This confirmed the need in the researcher's mind to collect interview data from Mr. T.

The researcher asked Mr. T to designate four of his classes as participants in the study. The classes were chosen according to the time of day they were scheduled, the days they were scheduled and the times when the researcher was able to visit the school.

The researcher selected the student sample from four science classes: two grade eight classes and two grade nine. With the cooperation of Mr. T, the researcher gave a brief presentation to each of those classes as to the purpose of the study and the researcher's role. Students were then encouraged to do two things: (1) cooperate with the researcher if requested to be interviewed and (2) take home a parent consent form giving the researcher permission to interview the student (see Appendix D for a copy of the form).

The researcher received 36 signed consent forms from the more than 90 that were distributed. Each student's name was given a code number. Using a standard table of random numbers, the researcher listed numbers from the table that fell within the range for the student names. From this list the researcher then recorded those numbers that matched those associated with student names. Another list of student names associated with returned permission slips was made for each of the four classes.

With each new class list that now varied in length from 6 to 13 names, the researcher approached students, in turn, to ask for their participation in being interviewed. Two students declined to be interviewed.

The researcher attempted to achieve a balance across the four classes and across the two grade levels with respect to numbers of students. Three students agreed to participate from one of the grade eight classes and four from the other. Six students agreed to participate from one grade nine class and three from the other. One student from each of grade eight and grade nine did not show up for the interview.

No attempt was made to select equal numbers of boys and girls. The final sample of 14 consisted of: 3 grade eight girls, 3 grade nine girls, 3 grade eight boys and 5 grade nine boys.

Data Collection

Within one week from the time the parental permission slips were distributed, the researcher began taping lessons and approaching students at the end of lessons to schedule interview times. Because many students arrived at school by bus just before the beginning of the morning registration period, the researcher chose to interview students in Mr. T's classroom either during the 80 minute lunch break or after school. Students had their preference as to time of day and the day itself.

The researcher initially focused the interview by reading aloud a predetermined, 60 to 100 word excerpt from the previous day's lesson. The excerpt was a piece of teacher talk that included a directed instruction for students to think about something. Each respondent recognized the passage (see Appendix B). Interviews were generally half an hour in length; a few lasted 40 minutes. All interviews were audiotaped with the student's permission.

Eight students elected to be interviewed with peers. Thus, six students were interviewed individually while the remaining eight students were interviewed as a member of one of four pairs. The researcher felt the presence of a peer gave students confidence and support for voicing their perceptions, so did not insist on individual interviews. Mr. T was not present during the interviews.

Within a few days, the researcher presented each student with a transcription of the interview. Students were encouraged to add relevant information and to identify transcription errors. They were also encouraged to identify misinformation and miscommunication. Two transcriptions appear as Appendix E: one of an interview with a single student, and one of an interview with a pair of students.

Once all 14 students had been interviewed and follow-up meetings (12 students only) completed, the researcher approached Mr. T who agreed to be interviewed during a lunch period. The interview was audiotaped. At home, Mr. T read a complete transcription of the 60 minute interview and penciled in a few additional comments. This transcription appears as Appendix F. He promptly returned the transcription to the researcher.

The researcher arranged two additional meetings with the teacher to discuss issues raised by Mr. T in the initial interview. Additional hand-written notes were made on these occasions. These meetings were not audiotaped in order to make the teacher feel more at ease. Several weeks later the researcher presented Mr. T with a discussion of issues that emerged from the interview, organized around themes. Little additional data was gathered at this time. A final revision of this discussion was mailed to Mr. T who read the paper and offered two minor revisions.

The researcher met with 12 of the students and presented them with his interpretation of issues based upon the initial interview and follow up. The students added very little information at this point. A final revision of the interpretation, organized by themes, was mailed to students with the request that it be mailed back to the researcher with or without suggestions for change. Seven of the 12 papers were returned. Three students added additional comments or suggested changes in interpretation. The researcher incorporated two of the changes and rejected one student-suggested omission because the researcher felt it to be relevant. Although only seven of the final revisions were returned, all 12 student interpretations were later included in the analysis. The researcher chose to include all 12 because the final revisions were format changes only; not substantive ones.

By this time one of the original male respondents had moved to another city and was no longer contacted. Another male student twice did not keep an appointment for the original follow-up meeting. The researcher decided not to press further with that student.

Prior to the final meeting with students during the early part of the next school year, the researcher attempted to gather supportive data for the interviews and observations by requesting a written description or account of "your experience in last year's science class." Most students attempted this activity and handed the researcher a one-page description at the final meeting. The most detailed account is given as Appendix G.

Validity

Two techniques were employed to establish validity with respect to the interview schedule. First, as a check on content validity, the researcher had two colleagues experienced with interview methodology critique the instrument. Second, feedback from those students who participated in the piloting helped provide useful suggestions as to the appropriateness of questions and language.

In qualitative research, validity may be interpreted to be "the adequacy of a description of a social situation (Dawson, 1977, p. 1)." Validity may be viewed, then, as the degree to which descriptions and interpretations accurately reflect respondents' meanings.

To establish validity the researcher sought respondent reaction to the initial interview data and, later, to the data analysis. One purpose of the immediate follow-up was to ensure that the respondents felt comfortable with what they had said; that it was what they had intended to say and had thought to be true. A second purpose was to have respondents confirm or disconfirm researcher interpretations.

Analysis of the Data

The researcher analyzed the data at three levels. Initially, the researcher confirmed student and teacher perceptions embodied in individual descriptive accounts (see Chapter III). Second, the researcher identified epistemological themes or recurring patterns from one student to another, that is, across many students: "shared" perceptions of life in the science classroom.

Third, a deeper, ontological level of meaning was sought in order to come to a fuller understanding of these respondents as science students. Major epistemological issues from Mr. T's account are identified and analyzed in the context of Mr. T's apparent world-view. The major objective of the data analysis is to "paint a picture" of how junior high school students perceive their experience of school science and, thus, to understand what it means to be a science student.

Generalizability

In this study, generalizability is achieved to the degree that the reader chooses to identify with the explanations and conclusions suggested by the data analysis. If the detailed results and explanations strike a responsive chord in the reader; that is, are consistent with the reader's own experience and world view, then the findings may be treated seriously and communicated to colleagues.

CHAPTER III

INTERVIEW AND OBSERVATION DATA

Introduction

This chapter portrays a "snapshot" of classroom life as seen through the eyes of Mr. T and 12 of his students. Mr. T and the respondents are described in the context of the physical setting. Attention is paid to the nature of the interaction between students and their teacher and, in particular, what is communicated between Mr. T and students. The chapter presents (1) a description of the physical environment of the science classroom, (2) a composite picture of classroom routine, (3) a description of Mr. T's curriculum-in-practice, (4) a selected sampling of classroom communication and (5) a description of respondents and their perspectives on classroom activity. Three interview transcriptions and one student's attempt at phenomenological description are provided as Appendices E through G.

Physical Environment of Mr. T's Classroom

Mr. T's classroom is essentially square, about 35 feet along each side. Seating for 32 is arranged around four evenly-spaced, hexagonal islands in the back three-quarters of the classroom. Four, black-surfaced trapezoidal tables variably adjoin each island at a corner of the island or along one side of it. Twenty-six students may be comfortably seated facing the teacher's desk that is positioned near the center of the south wall. Six students face Mr. T at an angle other than face-on. A plan view of the classroom is given as Appendix H.

Two exits are found at the SW and SE corners of the room. One exit leads into a hallway directly; the other opens into a science preparation area, then into a hallway that is at a right angle to the first one. Near the latter exit, to Mr. T's left, is a mobile demonstration table that is usually covered with materials. For students when seated, this table tends to visually mask the exit to the preparation area. The door to the prep area is always kept closed.

Counters run along the east and west walls. Cupboards are built in below each counter. Tackboard is fixed to all four walls. Shelving and textbooks border the tackboard on the west wall. A large chalkboard covers much of the wall behind Mr. T's desk. A periodic table of elements hangs to one side of a pull-down projection screen above the front chalkboard. An overhead projector sits on a moveable cart against the front wall near the main exit. An electric clock is wall-mounted above the screen. Prominently displayed high on the front wall just inside the main exit is a sign "reminding" students not to eat or consider eating certain foods in the classroom.

During lessons while the researcher sat to one side of the classroom or at the "back", he was struck by the feeling of close proximity to Mr. T and his students. This closeness is achieved, in part, by the shape of the room and by the clustering of tables. During instruction all students are within 20 feet of Mr. T who generally positions himself on a high stool near his students. He often sits on the stool holding a wooden metric ruler by one end.

As the researcher sat near one of the front tables he noted the possibility of making eye contact with fewer than one half the students. Six students at the front are able to see most of their classmates. Those at the back, however, can make eye contact only with those to their sides or the six at the "front". All students have a good view of Mr. T and can make good eye contact with him.

A variety of resource materials are located on open shelves, racks and tackboards. Mr. T keeps classroom sets of textbooks on shelves at both sides of the room. Students sign these out after class. These are intended as additional information sources for short writing assignments. Only a few students in any given class signed these out during the researcher's presence. It appears that a majority of students make use of the books although they sign them out on different days. A class set of a prescribed text is available along with several copies of two additional titles.

Many science and outdoor magazines fill the rack at the back of the room. The researcher observed no students at the rack during his visits. Mr. T made no mention of magazines during the researcher's presence. Magazine covers do not appear to bear any relationship to the topics studied in those classes observed. For these students, then, those magazines were not an information source at this time.

Display materials cover bulletin boards along the side walls of the classroom. These materials remained constant during the observation period. Some of the illustrated material supported the topic under study in the grade eight classes.

Most student activity appears confined to their tables. In one lab activity, students moved freely in the room utilizing both the glassware on one side counter and the counter space itself. Student tables act as a physical focus for students working together as teams. Mr. T distributes and collects lab materials from his demonstration table. During one class, Mr. T positioned the moveable table in the front of the room to carry out an electrolysis demonstration.

Classroom Routine

The demeanor of students entering and leaving Mr. T's classroom is relaxed and energetic. As students file into class many are talking with one another; others enter by themselves. Mr. T is usually standing at his desk at this time. Some students greet Mr. T with a "Good morning, sir." Invariably, a few students approach Mr. T with questions about assignments or missed classes. Mr. T's voice can be heard over the general background chatter and occasional laughter. His voice carries well although he is speaking quietly.

Most students move directly to their tables and place or drop their books on top. Some students remain standing until the bell rings. Occasionally, a student returns a textbook to one of the side counters or shelves. When the bell rings all students immediately move to their seats except those in conversation with their teacher. Students continue talking. Few open their books. Within one minute of the bell Mr. T moves towards the class. A few more students begin turning pages in their 3-ring binder or notebook.

Conversation with students at the beginning of class may concern school events or club activities. Mr. T is an active participant in both. In half the classes observed Mr. T answered questions prior to the beginning of the lesson.

Mr. T begins most lessons with reference to a page number in one of the lab investigations or to a concept from the previous lesson such as "Okay, let's get back to ions." The only observed exceptions were a discussion of a written test and course-related announcements such as the showing of a film during the lunch break. During the research period students were involved in the following activities:

- executing a highly structured lab "experiment"
- observing a demonstration and recording observations that are often teacher made
- answering questions based upon lab activity or demonstration (answers often provided by Mr. T)
- watching a film or filmstrip
- writing a test

The bell signals the end of the class. Academic activity is suspended at this point. During the period of research Mr. T never formally closed a lesson. Students immediately begin leaving their desks. Mr. T offers a comment or two such as "We'll continue that Monday" or "Okay, we'll continue there on Wednesday." His final remarks may take the form of emphatic reminders to students as in "Please have page 3 finished for tomorrow." A few students stop by Mr. T's desk to check on tests or assignments, or to check out books.

Mr. T's Curriculum

Mr. T's eighth and ninth grade science programs are organized around a set of units that Mr. T himself authored. Each course is comprised of twelve units.

Each unit is organized as a logical series of investigations, almost all of which are based on student hands-on activity or teacher demonstration. Two such investigations are given as Appendix I. Mr. T is flexible in his choice of investigations within each unit. Depending upon the availability of equipment, the abilities of students and the length of a given unit, the time Mr. T devotes to a unit varies. A unit could take as little as two weeks or as long as three and a half weeks. Mr. T does not give students options from which to choose activities.

The researcher observed that Mr. T keeps strictly to the unit booklets. Occasionally, he modifies the curriculum-as-planned. For example, Mr. T altered the students' assignment as given in the investigation.

> Then I'd like you to try during class time to answer the questions on page three with the exception of Part A, Question 3. I don't think you're quite ready for that yet. So you can leave that one out right now. I'll be going over it, but you can leave it out as you go through.

On another occasion he omitted a procedure because equipment was not available.

> Today, I'd like to demonstrate the first experiment to you. We're not going to do it exactly as it says on page 5, 6, 7, 8 and 9, but we'll be just about finished there by the

> end of the day. . . . We're not going to do the Brownlee apparatus this year. We don't have enough battery chargers. We did last year but somehow we're missing three of them this year. . . . We're gonna do _just_ the Hoffman apparatus. It has some other advantages anyway as you'll see in just a minute.

Mr. T encourages the use of prescribed textbooks at home as sources of information to help students complete written assignments based upon lab investigations. The researcher observed students signing out and returning texts but little use is made of them during class time. During one lesson Mr. T stated a preference for his being up in front of students explaining a concept as opposed to their searching for an explanation in a textbook. Mr. T uses most of the class time for lab investigations or to correct and briefly discuss questions based upon them.

During the period of study the researcher noted that at no time did Mr. T refer to unit objectives or communicate the purpose for the investigation on which students were presently working. Mr. T, however, clearly states student procedural objectives for each lesson at hand.

> Today I'd like you to finish up the experiment you started the other day. . . . I'd like you to finish up the assignment on page 2 _and_ try to

> answer the questions on page 3. . . . On page 2 you'll be doing the third type of experiment.
>
> I'd like you to try page 3. We'll go on and do page 4 later, but I'd sort of like to go over questions on page 3 before you sort of go off on your own and do page 4. They're just more of the same but I'd like you to have an idea that you're doing things right or how to do them right before you go to the next page. Your job right now is to do the experiment and then to do page 3.

The primary formal source of feedback students receive is through test scores. Mr. T administers unit tests once students have completed the necessary assignments. He expects students to make up missed work before taking a test. Mr. T also gives students credit for completed lab investigations. This is done by checking lab books each reporting period. Credit is also given for written assignments and projects.

On occasion, Mr. T relates his own life experiences with the expressed hope of passing along information that might be helpful to students. Mr. T considers this to be part of his teaching. For example, the day following one of his multiple choice unit tests Mr. T remarked to his grade nine class:

> I'd like to again talk to you a little bit more about that multiple choice [exam] and studying for those exams. There are many ways, but any

> way you can get that information to actually recycle right through the brain so that it has to go in and back out again will help you learn. . . . [At university] I'd have about 250 pages of notes during the year on each course. I'd start summarizing a few weeks before exams and I'd narrow each course down to about 20 pages or so. I'd rewrite things, slightly shorter in a more organized form, put them together and rewrite everything out. . . . If you summarize and shorten things up and then keep writing things down I think you'll take it in a lot better than [when just] looking at it.
>
> Even if you're asking each other questions, as long as you've had to think and come up with an answer, the brain has got your mouth in gear, hopefully. And the answer, if it's coming out correctly, you'll remember it.

Classroom Communication

The researcher found the teacher an imposing figure. Mr. T's robust frame is invariably cloaked in a white lab coat adorned with student graffiti. This visual image is further enhanced by a deep voice that Mr. T projects well beyond the wall at the back of the classroom. He commented that this is done deliberately so there is no question of his being heard by every student. Mr. T uses a relaxed, unhurried and rather effortless delivery. The researcher felt comfortable listening to Mr. T.

During instruction, Mr. T often interacts with the class from a sitting position on a high stool "squarely" facing most students. At this time, the front-most students are to both his sides. He varies from this position during a demonstration or when referring to visuals about the room. This has not always been Mr. T's classroom posture. At one time early in his career he had felt the need to be excessively mobile to secure student attention. Mr. T soon concluded that students found this behavior distracting. Now he relies on eye contact, facial gestures and voice modulation to keep students' attention. Mr. T is highly animated without using gross motor movement.

Mr. T uses a loud voice to gain the attention of his students. They respond by appearing to listen. The researcher observed that a few students would continue talking quietly while their teacher went on with instructions and explanations. Mr. T appears tolerant of this as he was never observed drawing students' attention to it. It seems highly likely that Mr. T is aware of any muffled conversation because he continuously scans faces of the entire class. The researcher felt this conversation did not interfere with the ability of these students to hear Mr. T.

On one occasion when Mr. T moved from addressing the class as a whole to attend to individual concerns, the level of student chatter increased. As a group students seem to be keying on the teacher, giving him their attention only when he addresses them as a group.

Overall, the researcher observed very little dialogue between teacher and student in the large group setting. Mr. T responds to queries freely. However, he was observed neither probing students on their questions and answers nor explicitly encouraging the development of thinking skills beyond the level of recognition. If "higher order" thinking skills are being promoted it is done so implicitly through the questioning strategies of the lab activities rather than orally in the large group setting.

When students are acting on teacher instructions, Mr. T varies his approach to handling student chatter. Early in the period he seems less tolerant of talking when students are not responding. For example, in one class he asked students to complete questions based on an earlier activity. A student was conversing with his neighbor as Mr. T spoke:

> Do you have that one, Walter? [Pause, as Walter looks down at his book.] Would you get to it then please?

Later, when some students were slow in locating a page of their lab booklet and one minute had elapsed, Mr. T began:

> I just made a statement saying that I'd like to give you some pieces of information. We've got chatterers in three places and a drummer over here. Why are you looking around for the drummer, Robert? [One student senses the humor in Mr. T's remark and briefly chuckles outwardly.] I'd still like to get this information across.

Mr. T treated Walter's inattention at a nearby table in a relatively quiet way. At the same time, his voice carried with it a sense of authority, yet respect for the student. In the second example above, Mr. T addressed the entire class. His voice seemed to reflect a less patient attitude. He appeared to use Robert's behavior for effect: to remind students of the seriousness and importance of the task at hand. The researcher noted that Mr. T had not explicitly called for student or class attention but seemed to expect their cooperation and attention while asking them to find page two of the lab activity to which they were presently attending.

Once students are engaged in activity and Mr. T is not the focus of student attention, quiet conversation is the norm. During lab activity, Mr. T frequently provides guidance by way of specific directions or cautionary remarks. He does not ask students to stop talking at this time. He feels students are able to hear him over the background chatter. It is apparent that Mr. T has his own standard as to what is an acceptable level of noise or chatter and what is not. He seems to use the degree to which students are on task as one criterion by which to gauge the effect of classroom conversation upon student learning.

The researcher noted that private conversations frequently do not relate to the substance of the lesson. Only during lab time does much of the student talk relate to procedural matters for carrying out the assigned activity. Expressions such as "Hand me _that_" and "Have you got the _stuff_ yet?" are audible. Late in the period as students complete observations, Mr. T permits a higher conversational noise level. He does not show concern that this might be distracting to students attempting to answer questions in their books.

During lab time Mr. T circulates from one table to another providing assistance with procedures or student questions. During the period of this research Mr. T was seldom observed near his desk and never during a lab activity.

Mr. T communicates an awareness of student academic progress and a concern for their well-being. On the day following a test Mr. T addressed two students in the large group as follows:

> There's a couple of people . . . [who] haven't written the exam from yesterday. [Bill], I know you're nowhere near ready to write . . . . [Judith], I expect you should be able to, but since you were away I would like [you] to write it at some time when I think you won't miss out on something else too much. So you should be ready to write it pretty soon but I won't get you to write it today.

An important aspect of Mr. T's communication with students is his clear enunciation, word emphasis, simple language and slow-paced delivery. These characteristics seem appropriate for these students. The researcher noted the absence of student requests to have sentences or words repeated. Mr. T seems to choose non-specialized words to convey his intent and facilitate understanding. Concrete examples are expressed succinctly.

The language of science and that of the student lab booklets is often not as "simple" as Mr. T might assume. For instance, during one class Mr. T interrupted the group to offer an explanation of "products."

> [A] question has come up by several people. Let's see if we can clarify that. Question A, Part A that is, Question 2 - the term "products." I thought it would be a natural for people to figure out what we're talking about but it's come up so often, I guess it's not. The product in a chemical reaction is what you end up with. The product of the reaction. It's what you end up finished the experiment with.

During classroom instruction Mr. T occasionally uses metaphorical language. Examples are concrete, often highly visual, and based on shared experiences that students could reasonably be expected to have had. For example, to describe the functional connection between brain and mouth Mr. T remarked "the brain has got your mouth in gear." Mr. T related to the researcher how a student had made him feel "as low as a worm's belly."

For the most part, the researcher observed Mr. T's students to be quietly attentive while he spoke. The researcher has no reason to believe that the observed teacher and student behavior were not typical in light of the researcher's presence. Only one student who was interviewed perceived an uneasiness, a slight change in the pitch of Mr. T's voice. Other students interviewed were unable to perceive a difference from the 'normal' class experience or did not express one.

Mr. T's Perspective

Interview data are presented below as emergent topics or categories. As much as possible the information is given in Mr. T's actual words. A complete transcription of the formal interview with Mr. T is given as Appendix F.

Communicating with Students

> One of the things that I was doing . . . and I usually do it when I am making some kind of a lecture is to take little things here and there and try to communicate them. I suppose I am communicating, trying to communicate with the whole class at any one time. But through eye contact and so on I try to communicate with some students saying "Hey, you know I think maybe you can benefit from what I'm having to say." So there's that and even the eye contact coming back tells me quite often, I didn't notice here particularly, quite often I'll say something I think everybody gets but then I'll take a look at one student, or two students or something, and there's a very puzzled look on their face which says to me "Okay, I'm not hearing . . . something I can understand. What are you talking about?" There's positive eye contact and there's negative eye contact. I think I use both eye contact and facial expression.
>
> Yah, I look at students. I try to look at students and communicate with them while they're communicating with me without the rest of the class necessarily being aware that I'm talking

to them. So, sometimes when I talk about them I just refuse to make eye contact with them at that time . . . but they'll know whom I am talking about.

One student in . . . the last few months . . . has been having some trouble in my class and she's come up to me afterwards and . . . said "You were talking about me in class today, weren't you?" I said "Yah, I was", and I'd ask her if she thought the other students knew that I was talking about her and she said "No." They like to know you are concerned without giving them away.

There are some cases in grade eight science where I say "Look. I'll try to make this as painless as possible. I am your friend despite the material you must learn. I don't find it interesting and though I find most things interesting, if I don't like it you probably won't be crazy about it either." You know if I sit there and look like I'm bored out of my tree they certainly are going to be too.

I think I relate through my physical appearance that I'm enjoying what I'm doing most of the time. I think quite often the rewards in teaching are the fact that you're making a visual, positive communication with the student or some other kind of positive communication and having them respond positively. Not all of them do it but I think that a lot of the reward in teaching is that you feel good. You wink at a student and they smile. They say "You know, you like me. I like you back. You're okay." I don't have to say that. I feel good in the communication I get back from most of the kids.

I know when I leave my classroom which kids are gonna get excluded by substitutes because they . . . can't

> interpret the kid, interpret the way the kid is saying things . . . . A rapport is developed between the student and me that allows him to say things that might annoy a less aware substitute.
>
> I like the chance to be communicating with kids. The only other kind of thing (vocation) that I would be interested in really would be something along the lines of music or drama in which case I'd be communicating with kids.

Being Human

> In my first few years teaching every once in a while I would stop and say "Hey, I thought I've done this correctly and now what I'm getting back and what the understanding of the students is, is not what I thought I was teaching them." So, therefore, I would have to stop and go back and teach them again. Their incorrect relationships and answers makes me more human to kids. I can show empathy with their lack of understanding. I like students who have been kinda sitting back quietly to feel that I feel more comfortable with them if they're trying to communicate . . . with me and that I can't really help them very much if they're not. I try to communicate this to students through personal warmth in directly telling them that.

Being Animated

> Sometimes I sit on my stool frontwards and I have my hands just hanging. At other times I'm talking with them. I . . . know that I do try to put emphasis on by hand motions . . . . When I talk about "putting it through the gray cells", I'll point to my head to sort of emphasize what I'm talking about as far as gray cells go. I know that my hands do not stay on that stool. They move around. If you're animated to a certain

extent you are attracting the attention of the students you're trying to communicate with and if you're sitting there completely still you're _not_. At times I'll walk around the room and talk, sometimes just to be animated myself and sometimes to discourage too much animation amongst the students at that particular time. I am semi-conscious of hand movements. I try to use my voice to produce energy as part of animation. Being animated is having a bright face and using quick movements that attract attention. At all times I try to be energetic in my speech and hopefully my voice varies enough to not become monotonous; for example, with the speed of words and hesitation.

Eliciting Interest

I didn't feel animated student teaching. I started 'subbing' and then I began feeling that I could motivate kids by showing that I was motivated to do the job. I maintain that the teaching business is an entertainment business. If you can't entertain them enough to get their interests over and above all the other interests that they have in and out of school, then, you can't motivate them whatsoever. And whether the motivation be through a personality or through subject matter or whatever it happens to be, it's gotta be there somehow. Kids _always_ show interest in certain demos and perk up, wake up and get involved because they become interested.

Enjoying Teaching

I really like junior high students. I am in teaching because I like young people. I don't think I like grade seven's. They drive me crazy, their enthusiasm and their "Watcha doin' now?" sort of thing bothers me. But generally

> I like them. I feel quite comfortable with them.
>
> Certainly, I can't say that I enjoy what I'm doing all the time. For example, I have to teach certain metric units to grade nine students that are not derived from anything they can relate to. That's not enjoyable.

Getting Along with Students

> I'm not in teaching for a popularity contest . . . . I can get by. I get by fine. I don't have the ideal that I must please all the students all the time. I can live with that! I know that some students and I are going to get along well and I hope most students and I are going to get along well. And there are students I'll never get along with.
>
> I suppose when I first started [teaching] I couldn't see why I couldn't get along with everybody but I learned pretty fast that that doesn't work. It doesn't matter whether you're teachers or students or friends . . . or whatever. But I feel good in the communication I get back from most of the kids. An excellent example a while back. I took a strip off one of the kids . . . . Just tore up one side of her and down the other and just ten minutes later she walked out and had left me a Christmas card on my desk, [the] only one in the class [who] had left me a Christmas card (laugh). I talked to her afterwards and said "You know, you made me feel as low as a worm's belly when you finished. But at the same time I certainly felt good about it."
>
> I've seen teachers on staff here whom I have felt if you can't relate (speak the same language) you shouldn't be teaching and they're complaining all the time. Now, when I complain, I'll complain

> about an individual student and most of the time it's done in a joking fashion anyway. There's very few.

Showing Concern

> What I'm trying to do is make students aware [that] I'm trying to help through my experience [although it's] not my first concern always. I sort of pass on a recipe for at least some academic success just as you'd . . . to people that you are concerned about. Just as I would pass on a recipe for some kind of a meal to close friends if I thought that they would enjoy that particular meal or benefit from it. To me in a way I guess it's my recipe that worked for me. Whereas, when I didn't follow that particular recipe things did not go that well for me. They did for a while until finally I had to have some other method of going about doing things and that seemed to work out quite well. So, I guess I'm hoping that they will benefit and I know that I never do but I guess I'm dreaming, hoping they will benefit by somebody else's mistake rather than having to find it out themselves.

Having Expectations

> If [students] were given a specific task to think about and come up with an answer, I would expect that most of them, I certainly never expect that all of them, are going to interpret what I want them to think about but I want them to organize their thoughts somehow and be able to come up with an answer as opposed to coming up with some kind of a wild guess. There's a difference between making a wild guess at it and stopping and considering it, at least a little bit of time trying to put it into a clear answer of some sort. I expect them to see how the question relates to the framework of information they have.

Getting Involved

Getting involved becomes a learning process. Being a spectator, learning - learning can't be particularly good spectator sport. It's much more effective as a participant than it is as a spectator, just trying to watch it coming off the page. Weak students who try to take part in class do better than [do] weak students who do not take part. When trying to answer, students choose whether it will be oral or to him/herself.

Trying

What I am hoping they are saying is "Okay, I will attempt to come up with an answer. I don't know whether I can come up with that answer or not but I will try to come up with an answer. And I'm not gonna get ridiculed or feel embarrassed if my answer isn't corrent. That your request of me is to consider an answer based on what I already know, put it into words and whatever the answer is it will be accepted in some degree or other." I think students feel this way because they continue to try and don't give up with one wrong answer. If they're not trying to communicate back with me I don't know where I stand with them or where they stand with me.

Restructuring

I think just as long as they've had to restructure whatever they were taking in, in such a way that they can communicate it back. You can't communicate without thinking. Whereas . . . you can look at a piece of paper without doing any communicating and then you don't have to be doing any thinking at the same time. So, I think the thinking just means . . . that they have to think enough in order to express what they . . . want as an answer.

> [Restructuring implies] putting in terms they *personally* understand and relate to. They can't avoid somehow conceptualizing what was going on. And if they haven't practised trying to conceptualize and come up with answers they aren't going to be able to do it [on an exam]; if they haven't practised organizing ideas in their own mental framework.

Encouraging Students

> What I've been trying to encourage all year long is the fact that if [students] have not attempted to come up with answers on their own during class work, during their own time then at the time of exams they will have not been practising this particular skill and will be just out to lunch as far as being able to answer on an exam. I try to develop a *positive* approach rather than "demand." What I'm hoping they're getting is encouragement to attempt things and feel that they will not be ridiculed . . . . Students with difficulty almost always are in a position that makes them feel they may do something embarrassing. I try to alleviate those fears.
>
> I try to encourage them to have something down on paper. At times when I mark it, I mark it mostly for their attempt at doing the answers rather than the correctness of their answers so that at least I know they've had to try to come up with some way of communicating back to me.

Getting the Message

> I think if they don't come up with the kind of feeling that I expect they're getting and this happens quite often . . . it's happened to me many times, it's up to me to reteach the lesson in such a way that they *are* getting *my* message. I'm getting a little better at reading

> students I think. So, yes, I think they're getting the message. I'm not sure I'm articulating what they're supposed to be getting as clearly as you'd like me to or even as clearly as I'd like me to. [Students tell me that] I speak clearly and finish ideas.

Mr. T - A Researcher's Perspective

The most striking aspect of classroom life is the way Mr. T seems to dominate during the instructional part of lessons. He does this through teacher talk. At times, his talking might take precedence over students making their own observations directly. On one occasion during the demonstration of a student investigation the researcher noted Mr. T describing what was about to take place. He "announced" the observations as they appeared and acknowledged to the class that he was "trying to put words in your mouth, I guess." It seems that not all students are expected to actually see results; Mr. T describes them for those who are not able to see from where they sit.

Often Mr. T suggests what is "supposed to happen." Students are not encouraged to make predictions. Student oral participation is minimal, discouraged, perhaps, by continuous teacher talk. Mr. T seems to be directing student thought, suggesting the kind of thoughts or thinking that is appropriate for the occasion. He seems to be modelling thinking by verbalizing his thought processes. In so doing Mr. T may be losing the opportunity to monitor student thought and to give immediate feedback. Simply stated, Mr. T may be the principal source of science knowledge for his students.

This modelling extends to lab investigations. Having demonstrated a procedure, Mr. T may be reducing the need for students to wrestle with problems and to employ higher thinking skills. Ginsburg and Opper (1979, p. 225) argue that for much learning to occur when adolescents are performing these experiments, "parallel mental activity, such as thinking of alternative types of results and their meaning" must accompany physical actions. These authors question the degree of success for those teachers who "spoon-feed" their students.

Mr. T poses the questions during instruction; students raise very few. Questions seem to be treated as part of a "running commentary." Wait-time is very brief, always between one and two seconds. It is highly probable that this is insufficient time for many students to grasp the import or significance of the question, let alone formulate a response. It is, therefore, also highly probable that students do not get involved in thinking at these times but simply wait for the teacher's answer - the "right answer." The researcher rarely observed students challenging an answer or asking for clarification or elaboration. During one lab demonstration on chemical reactions some "needed" explanations were not given. Students did not ask for any. They simply do not question during demonstrations. The researcher also observed few instances of students seeking explanations when they are correcting assignments.

Teacher dominance is reflected in the emphasis given the content of the unit booklets. At the beginning of one class in response to test results, Mr. T encouraged students to write out, summarize and verbalize course notes. Yet, as part of the day-to-day curriculum, he does not seem to encourage students in the writing process. In an effort to reduce student "work" Mr. T suggested on one occasion that "notes can be done by underlining what is already there." The main thrust of the assignments appears to be the securing of correct, short-answer responses to a long series of teacher-initiated questions. Teacher knowledge is, thus, stressed. This represents another way in which Mr. T dominates the school science experience.

Themes Describing Student Perceptions

Excerpts from student interviews are organized below into experiential structures or themes in order to strongly suggest aspects that make up the whole of the school science experience. Each theme seems to portray part of the school science experience as students perceive it. This organization helps establish a thematic perspective for the initial analysis of student data, presented in a student-by-student format in Chapter IV.

An examination of student interview transcriptions reveals three major themes and ten minor ones. In order of frequency of occurrence, major themes include: (1) liking science, (2) being interested and (3) boring. Each of these was identified by at least half the students.

Minor themes are those identified by at least two students. These are: (1) having fun, (2) being excited, (3) feeling the need to pay attention, (4) listening to the teacher, (5) thinking, (6) gaining meaning, (7) understanding, (8) taking his word for it, (9) being important and (10) getting help.

It is important to keep in mind that the interview structure was designed to elicit a student's response to a specific point of a single lesson. A second aspect of the design afforded students openness in which they could volunteer comment as they saw fit. Neither aspect of the interview schedule was intended to reveal those themes that actually emerged.

Several additional issues, descriptive of the school science experience, were raised in the interviews: challenging, frustrating, being encouraged, being confused, being wrong, feeling good about it, being curious, having confidence, being concerned, trusting the teacher, knowing your place, wanting to learn, asking questions, thinking it is better this way, thinking it is pretty good and knowing.

Complete student-by-student interview data, each thematically arranged, appear as Appendix J. Self-portraits for each of the twelve students are also included. Pseudonyms are used.

Below, descriptions of issues raised by students are organized under three major themes. These are followed by brief descriptions of the ten minor themes.

Major Themes

Liking Science

Arlene: I like science when we're watching a film or doing an experiment or talking about a new unit or somethin' like doing diagrams. Science is my favorite subject [at that time]. He lets us be on our own. I don't like it when it's hard to understand as when there's scientific words. I like science about an average [amount] I guess. I kinda like it. Well, I like it better than some subjects. When you like it you feel happy; you feel more confident in it. I'll concentrate on it and understand and really pay attention. It's interesting in a way. You understand. When we do something I like, I know I'm going to be good at it. Otherwise, I'm generally looking at my books while the teacher is speaking or I'm watching him.

Barbara: I like science 'cause we're constantly learning new things. The teacher is never boring and we always do interesting things, experiments and stuff. Units are taught well because I understand everything: I get it "right off the bat". It's like a puzzle fitting together. It's always a challenge not knowing how the experiments will end up or anything like that.

Cheryl: I like science. You learn new things every day. It's exciting, different from other classes. I get to experiment, not just sit. You get to try things for yourself. Seeing yourself as a science student after you leave class depends on what you did that day. Like if it's something you really liked and you'd like to try it again, you might go home and try doing it yourself. I did that two or three times. I felt like I was smart and could do it on my own; I didn't need any teacher.

Edward: Science comes easiest for me 'cause I'm interested and usually understand what's going on. Therefore, I pay attention and like it. We get to do stuff: experiments, charts; action work that takes more than a day. I do the best in science 'cause I like science most.

Greg: I like science. I think I am learning a lot. I like doing what few experiments we do. The units we learn are very interesting most of the time. The people at my table are easy to work with and I receive a lot of help from him. My teacher makes it easier to get through the units. I respect him for his intelligence and size. There isn't much I don't like about this year's science. I like the films we've seen and the erosion unit. The year has gone by pretty fast; I kinda wish it hadn't.

Kathy: I either like it nor don't like it. It's okay; mostly all new.

Laura: I like science experiments and different things to do. Yet, I don't like science that much, especially if I have to write tests. I don't put much effort into science; it's not my best subject. If I have a test I don't want to go to science 'cause I do bad on tests. When we do experiments he lets us go on our own, in groups. You feel like you're your own special scientist. He doesn't baby sit you. He tells us what we're going to be doing and then let's us be on our own.

Martin: I like science 'cause the teacher's nice and it's fun. The teacher isn't strict; he doesn't get mad when little things go wrong. He gives you a second chance. He explains things very well. He doesn't put you on the spot by asking you questions you can't answer. That wouldn't be fun.

Nancy: You're not doing the same things over like in language and math. You can do experiments and discover things yourself rather than having the teacher tell you what's going to happen. You can find out for yourself. My teacher's easy to understand - the way he puts things and emphasizes things that will be on tests.

Being Interested

Cheryl: When something's interesting it keeps you enthused in what you're doing. It's not an everyday thing. It's a new experience.

Edward: Science is interesting. It's different from regular (other) classes where you just sit all day. It's characterized by action where we do experiments and write reports on them. I enjoy doing it, filling test tubes, watching to see what you've done to find out things that happen. . . . It's interesting when we do these chemical things. It's not always this way but some of the books (units) we do are. If you've been working on something too long in a certain section and if you don't understand, you sorta dislike it.

Fred: It's interesting, not boring like in some classes. There is a feeling of wonder as with experiments. They're neat 'cause reactions turn color and they're spectacular. Things burst into flame; I like this sort of stuff. It's kinda neat that you can do something like that. You can put two innocent things together and then it makes some kind of reaction that's pretty spectacular. . . . The class interests me in the kind of topics so I want to learn more. I am interested in some things particularly experiments and stuff.

Greg: I'm interested in different things, like when we took weather. When I'd watch the news I wouldn't know what HIGHS and LOWS were, but now I understand it. Science is not as boring as L.A. where I have to do a lot of writing. I'm interested when something makes sense.

Jerry: Science is an interesting subject. You learn about stuff you didn't know before. You do experiments; they're kinda fun. It's neat doing experiments 'cause you wonder what's going to happen next. It's often a surprise. For example, earlier this year the teacher inserted a burning splint into hydrogen gas and produced a loud pop (minor explosion).

Kathy: Science is interesting at times; at other times boring. It's interesting, doing some of the experiments we do, the way the group sets it up and the way we do it. It's something I've never seen before. It's interesting to find out what's gonna happen next. Interesting is sometimes just something new.

Nancy: If he says something that interests you then, sometimes, I guess you'll think about it later. If it interests you then it's something you like and it means something to you. You learn new things all the time. Experiments are interesting to me; you're discovering something new. For example, we worked with rocks, checking for hardness by grouping them and finding what kind of rock each is.

Boring

Arlene: Science is boring. Part of the reason is the teacher when he just talks all period. It's his expressions - the way he's saying it. I can't understand those funny, scientific, words. They're long and don't tell you the meaning. I'm bored when there's nothing to do. For example, you're given an assignment and you don't really know what that assignment is about. So, if it's boring, you don't know what you have to do. You're not really into it and you feel like you're missing out on something - misplaced. You're not concerned; that is, I don't care about it - science labs, books or assignments. We're not going to use it for our future, later on.

Barbara: My teacher never lingers on one subject or gets drawn away from the main topic. Boring means that something is tiresome. It's repeated or it's something that doesn't apply to you. You can tell right away if it's boring or not.

Cheryl: When things are boring (content) you don't really learn anything more. It doesn't have meaning; it goes in one ear and out the other. You might say "Who cares! I'd rather be outside playing baseball." Boring is pretty much the opposite of fun.

Doug: It's enjoyable doing experiments with friends instead of with the teacher because the teacher is usually boring. They (teachers) want everything perfect. You're stuck with them. During the experiment with the teacher, there's no chance to talk about outside activities which you can do with friends. I feel like going to sleep. You are watching the teacher do experiments and handle equipment. You don't have a chance to do it. You have a feeling you can do the experiment by yourself instead of the teacher instructing, doing it for you.

Fred: While you are interested in some things, when you get lectures and tests you're bored. When he's talking it could be interesting but not all the time. Boring could be considered the opposite of interesting but there is a middle ground as well where something is neither. When you just have to sit and absorb [material] as in a lecture then it's boring. Boring things are those that I'm not interested in such as tests and lectures, or, those that I've already done in other courses which have lost their interest. You've already heard all about it; all the wonder has gone.

Kathy: When I don't understand, it's boring. Once we had to do a unit by ourselves with no help from the teacher. That was hard. Most of the time when it's hard it's boring. I had missed some work from previous years but couldn't arrange to get help from the teacher. This made it hard.

Laura: When I am tired or when it gets boring I want to be excluded. I don't want to listen to what he's saying. Sometimes it seems the class is really long like the last period in the day. If it's the afternoon it (science) gets tiring.

Nancy: We just watch him but sometimes we're bored. Well, see there, he's talking about the same question for a long time. He'll go over stuff and I'll understand it. But if he reviews then it's 'unmeaningful'. I already know it; it's in your mind. It's boring, too, if I did it in some other year. When you're bored you're not interested; you're thinking about something else. You look around the class at other students, the board, posters or the walls.

Minor Themes

Having Fun

Barbara: Having the right teacher, a proper teacher, makes things a lot better, easier and more fun. You enjoy doing it. It's something you like to do or want to do.

Cheryl: When science is fun there is no repetition; the teacher does not go over the same stuff. You learn faster. You'll get into more and you understand what he's talking about faster. It's change. It's different, something new. It could also be interesting. My teacher tells jokes which make it fun. It's fun when you have a teacher who knows what he's talking about.

Doug: He makes jokes in class about a person, though not especially me. He'll pick any person as the [focus for jokes, sketches, etc.]. Experiments are enjoyable. It's enjoyable doing them with friends. I enjoy the way he lets us handle experiments in class. He doesn't often come around and instruct us. You can go faster. I like doing them. I pay attention when there are experiments.

Being Excited

Cheryl: I'm excited when I know what's going on. Being excited is trying out different things, new experiences.

It's learning to do things in more than one way.

Kathy: It's exciting to learn new things sometimes. It's a learning experience. Exciting means it's fun, interesting. It's exciting when we do experiments, like we did one time when we had to fill test tubes with water. That was fun, something I've never done before. Techniques such as using balances are useful and kinda fun.

Feeling the Need to Pay Attention

Doug: The way he (teacher) talks he wants to attract your attention using a high pitched voice. If he thinks a test will include some experiments that we did in class his voice will change.

Jerry: When my teacher's talking I'm usually watching him and the expressions on his face. You feel like you're paying more attention when you do this. So when you're looking around the room at posters and other students, you don't feel as though you're paying attention. When the teacher says something in a different tone of voice or when he wants to make something clear by repeating it, I sense that what he's saying is important.

Listening to the Teacher

Edward: Sometimes I don't hear everything he says but, because he's actively doing and demonstrating, I'm able to follow the lesson and understand him. Sometimes I lose track when I'm reading in the book (unit booklet).

Laura: If you listen to him you'd look interested and he'd ask you questions. If you look like you don't want to listen then he doesn't really bother you. Sometimes I don't want to listen. When he goes over something that's lengthy or repeats some things, he stalls. Then it just doesn't seem interesting. He raises his voice when he walks around. Loudness is somehow equated to his conviction about what he says - he means it! He is facially expressive. He looks into people's faces. I ask questions when I don't understand. He knows I don't and kinda winks at me and smiles. He'll stop and explain [something I don't understand]. I feel good sometimes, glad, when he tells us we don't have to do something 'cause sometimes it'll not seem interesting.

Martin: When I am watching my teacher I am usually listening to him. When I look away from him I tend not to listen. I think about something else. When my teacher is giving advice I get a mildly positive feeling; I get a good feeling from listening to what he's saying. Sometimes I don't concentrate on what he's saying. As I was listening to this excerpt (under discussion) I wasn't concentrating on what he was saying. I was waiting for science to get started. I was thinking about math: I can't do it (math) all; thinking about getting it done.

Thinking

Fred: You don't think all the time in class, so he tells you to think for certain questions. After a question he would say "think about this". This would be sorta your key. He expects me to think first, not guess, and come up with answers. My teacher uses different tones and hand motions to get our attention and to help us understand.

Jerry: He wants us to reason things out; look at all the different things and come to a conclusion of our own so as to know what we're talking about and whether or not it's right. By saying 'so?', 'so what?', 'who cares?' and 'tell me more about it', he wants us to specify more our answers to his questions. It serves as a check on our knowledge.

Martin: One thinks so that it doesn't go in one ear and out the other. There is a sense of 'working on' or improving upon what was 'taken in' when one thinks. There is a sense of trying to find an answer. The purpose of thinking is to be able to put things down if you're writing a test. It's a question of getting things out, getting the right words out.

Gaining Meaning

Barbara: I think the meaning I get is the same as the teacher's. He tries to adapt himself so he can talk to you properly. He uses a different vocabulary and tries to make it as simple as possible. In a way, you compare your way of doing it to the teacher's way of doing it and see if they're in any way the same. You think if it's just a good way of doing, a smart or reasonable way or you think it doesn't make sense and your way would be better. If it makes sense you understand it and it comes easily; you have no problem. You know if you get the same meaning, if you come out with the same answer or the same solution. You get his meaning by his attitude when he says it. You can just accept what he says 'cause he's the teacher. You hope that he knows what he's talking about. You have to get to know each teacher individually and adjust yourself to each. You consciously change your way of thinking for each teacher.

Cheryl: You get the meaning of what he says by his actions and speech. On "real [serious] things" he gets to the point and explains it well. It might be the way he says it or his facial expressions or his own charisma. Just the way he presents it all to you; his personality. He has an exciting voice. If it's the same dull, boring tone, then you'd lose interest. You start doodling on your paper or think of something else to do. It's the presentation, a step by step breaking up into sections so it's easier to understand. He'll explain it thoroughly, every way you can look at the question. You also get his meaning through his actions. He uses his arms, for example, to estimate the length of something; to give you an idea of how big something is compared to another thing. By the way he moves his hands you can visualize the structure in your mind.

Understanding

Arlene: When I understand something I feel happy. It comes easy to you. I get, or know, what he's talking about. The scientific words make the subject hard to understand.

Cheryl: My teacher looks at everybody. He looks at you to see if you're understanding, if it's getting to you and not going over your head. He senses my lack of understanding through my facial expressions. My face is screwed up if I don't understand.

Edward: Instead of just reading what happens you watch what happens. You find out a little clearer. You understand better; that is, you have a better view of things. You know what's happened. You see all of it. You should understand what will happen next - be able to tell after the experiment is completed.

Nancy: When my teacher explains things, that helps me understand. He lets us do most of the experiments and that helps you understand them. You see it happen better and remember it if you do it. This helps your understanding, too.

Taking His Word for It

Cheryl: Since he's had a way more experience than I've had and I'm new at it, I'll trust him. He's the teacher. I trust him 'cause he's older. He's taken more courses and knows more about a certain topic. I generally take the teacher's word for it whenever he expresses his point of view on something. That's most likely the best way to go. He knows about different aspects of life.

Martin: My teacher makes himself believable and convincing. He says what he thinks and what he believes. He's outspoken; he explains things as he talks. My teacher talks to us both from behind his desk and from in front. When he speaks to us from in front it's more important. Some teachers sit behind their desks all the time and when they get mad at you or they want to express something more than usual they'll stand up. Sometimes the reverse is true. However, this is not characteristic of my teacher.

Being Important

Greg: Something that isn't important is not useful. I might not have to use it; I might not need that information. Maybe I don't need to learn it; I don't need to know it for the course. I don't have to study and memorize it.

Nancy: When something's important the tone of his voice changes and he says it louder. Like you hear what he says but if he says something that's important, you can hear the change of his voice. If it's important then it's meaningful to me and may be used later. It's special. I usually decide right away if something is important or not. If it's important you pay attention.

Getting Help

Doug: He is a good teacher. He helps any student anytime. He insists they have first made the attempt, however. For example: homework. I don't have any free time after school and I can come in in the morning and he'll be there. He explains things very well and the way he sits without moving his hands and pointing [to me]. It bugs me, is distracting, when someone points at me.

Kathy: When I am confused I feel that I'm not part of the class or something. I ask for help and nobody helps me. When I have difficulties I'm scared someone is going to find out. So I find it difficult to go after help; 'I just never do'.

Martin: Occasionally, my teacher will tell us about some of the things that he did wrong which I, as a student, might do wrong. He tries to help us by relating his experience. You might go through what he did so he wants you to know what to expect. If he looks at me when he relates his experience, I feel that he thinks I might be one of the candidates for this kind of advice. Even if he doesn't look at me when he is giving advice, I can still feel this way if it relates to something I didn't understand in an earlier lesson. I'm not uneasy about it.

Nancy: He's a good teacher. Like if you need help or something, you just go to him and he'll explain it. He'll spend time on you when you want. He's nice. He'll say "If you want to come in for help, feel free to come and see me". After each experiment he goes through the questions and answers with us. This is good and helps the kids understand. He's the best science teacher in the school 'cause he explains things and you understand. He doesn't test you on things not taken in class. I get help if I don't understand something or if it's not clear to me.

The Student Perspective

All students acknowledge that they like school science or enjoy it. All but two indicate that there are times either when science class is boring or when they are not interested in what is taking place. Students support their attitude with a wide assortment of cognitive and affective descriptors. Although Mr. T is not always named, he is clearly implicated.

Students appear to like science for three principal reasons. First, there are many concrete, physical objects that are both visual and tactile. Students like films, diagrams, and handling equipment and materials.

> I enjoy doing it, filling test tubes, watching to see what you've done to find out things that happen.
>
> Things burst into flame; I like this sort of stuff.

Second, students like working in groups on a variety of activities.

> You don't sit there.
>
> [He] let's us go on our own in groups.
>
> It's enjoyable doing them with friends.

Students enjoy experiments, especially those they do themselves. Greg states that "I liked doing what little experiments we did." It is clear that not only does he enjoy them but wishes there could be more.

Third, students like to be independent; experience some freedom in not having the teacher overseeing each step in an investigation.

> Let's us go on our own.
>
> [Makes] you feel like you're your own special scientist. He doesn't baby sit you. He tells us what we're

> going to be doing and then let's us be on our own.
>
> You know you can do things.
>
> He doesn't hold your hand.
>
> You have a feeling you can do the experiment by yourself instead of the teacher instructing, doing it for you.

Student boredom and lack of interest appear to be associated with inactivity and repetitive or meaningless (student interpretation) information. Teacher talk is seen as boring when its content is repetitive or does not seem relevant.

> You've already heard all about it; all the wonder has gone.
>
> Well, see there, he's talking about the same question for a long time.
>
> But, if he reviews, it's unmeaningful.
>
> When science is fun there is no repetition.
>
> You're not doing the same things over like in language and math.

Students make distinctions about what is important and what is not; what is understandable and what is not. A few students are able to verbalize what is meaningful to them. They make their judgments, in part, according to Mr. T's actions; for example, when he uses (or does not use) emphasis or eye contact.

Some students make reference to their past experience when deciding that something is not meaningful. The following quotations typify student thinking:

> In a way, you compare your way of doing it to the teacher's way of doing it and see if they're in any way the same. You think if it's just a good way of doing, a smart or reasonable way or you think it doesn't make sense and your way would be better.
>
> When my teacher's talking I'm usually watching him and the expressions on his face. You feel like you're paying more attention when you do this. When the teacher says something in a different tone of voice or when he wants to make something clear by repeating it, I sense that what he's saying is important.
>
> When he speaks to us from in front [of his desk] it's more important.
>
> When something's important the tone of his voice changes and he says it louder. If it's important then it's meaningful to me and may be used later. It's special. I usually decide right away if something is important or not. My teacher's easy to understand - the way he puts things and emphasizes things that will be on tests.
>
> It's his expressions - the way he's saying it. I can't understand those funny, scientific words. They're long and don't tell you the meaning.
>
> If it makes sense you understand it and it comes easily.

> When science is fun there is no repetition; the teacher does not go over the same stuff. You learn faster. You'll get into more and you understand what he's talking about faster.
>
> It's boring, too, if I did it in some other year.
>
> It's the presentation, a step by step breaking up into sections so it's easier to understand. You also get his meaning through his actions. He uses his arms, for example, to estimate the length of something. By the way he moves his hands you can visualize the structure in your mind.
>
> After each experiment he goes through the questions and answers with us. This is good and helps the kids understand. He's the best science teacher in the school 'cause he explains things and you understand.
>
> I can believe him if he "means" it. That is, he's pretty serious about it - not smiling.
>
> Loudness is somehow equated to his conviction about what he says - he means it! He is facially expressive. He looks into people's faces.
>
> If [something] interests you then it's something you like and it means something to you.

Students perceive Mr. T as the authority and accept him as such. They respond to his suggestions for improving their study habits and learning techniques.

The following excerpts reflect some of the student thinking.

> Since he's had a way more experience than I've had and I'm new at it, I'll trust him. He's the teacher. I generally take the teacher's word for it whenever he expresses his point of view on something. That's most likely the best way to go. He knows about different aspects of life.
>
> It sounds like he knows what he's talking about and he's not confused. He explains everything clearly. It's all in one unit; he doesn't break it up and stutter. He doesn't have to go [and] look in his manual or book. He says something in a confident voice, not shakey.
>
> You can just accept what he says 'cause he's the teacher. You hope that he knows what he's talking about. You have to get to know each teacher individually and adjust yourself to each. You consciously change your way of thinking for each teacher.
>
> You don't think all the time in class, so he tells you to think for certain questions. After a question he would say "think about this." This would be sorta your key. He expects me to think first, not guess, and come up with answers.
>
> If you act like a teacher when you study, taking a book in your hand and talking out loud to yourself, you can understand what you're reading.
>
> When I do my science homework, I feel he's right there talking to me. When I'm reading over something I kinda hear his voice, the way he talks and

> emphasizes things. Picturing him talking helps a little bit. I think about it more clearly.

Students use different criteria upon which to judge whether or not something is important, understandable or meaningful. Most criteria relate to Mr. T's personal characteristics. Students view investigations as an important part of their learning. Students make little direct reference to the content of their unit booklets.

> I think the meaning I get is the same as the teacher's. He tries to adapt himself so he can talk to you properly. He uses a different vocabulary and tries to make it as simple as possible. If it makes sense you understand it and it comes easily. You know if you get the same meaning, if you come out with the same answer or the same solution. You get his meaning by his attitude when he says it.
>
> You get the meaning of what he says by his actions and speech. On real [serious] things he gets to the point and explains it well. It might be the way he says it or his facial expressions or his own charisma. He has an exciting voice. It's the presentation, a step by step breaking up into sections so it's easier to understand.
>
> The way he talks he wants to attract your attention using a high pitched voice. If he thinks a test will include some experiments that we did in class his voice will change.

> Sometimes I don't hear everything he says but, because he's actively doing and demonstrating, I'm able to follow the lesson and understand him.
>
> Instead of just reading what happens you watch what happens. You find out a little bit clearer. You understand better; that is, you have a better view of things. You know what's happened. You see all of it. You should understand what will happen next - be able to tell after the experiment is completed.
>
> When he goes over something that's lengthy or repeats some things, he stalls. Then it just doesn't seem interesting.
>
> If he looks at me when he relates his experience, I feel that he thinks I might be one of the candidates for this kind of advice. Even if he doesn't look at me when he is giving advice, I can still feel this way if it relates to something I didn't understand in an earlier lesson.
>
> After each experiment he goes through the questions and answers with us. This is good and helps the kids understand. He's the best science teacher in the school 'cause he explains things and you understand. He lets us do most of the experiments and that helps you understand them. You see it happen better and remember it if you do it.

A number of students regard Mr. T as helpful during the progress of lessons. His communication on an individual basis is appreciated. A sample of comments follows:

> My teacher looks at everybody. He looks at you to see if you're understanding, if it's getting to you and not going over your head. He senses my lack of understanding through my facial expression.
>
> He'll look at students that have the most problems with experiments. I know that he is making reference to me when he looks at me. Without his asking me [a question], his facial expression changes.
>
> I ask questions when I don't understand. He knows I don't and kinda winks at me and smiles. He'll stop and explain [something I don't understand].
>
> If he looks at me when he relates his experience, I feel that he thinks I might be one of the candidates for this kind of advice. Even if he doesn't look at me when he is giving advice, I can still feel this way if it relates to something I didn't understand in an earlier lesson.

In sum, students see school science positively. They approve of Mr. T whom they perceive as an important part of the experience. Students express a clear preference for hands-on "experiments" and, to a lesser degree, teacher demonstrations. They appear to keenly appreciate Mr. T's focus and the attention he gives them.

In Chapter IV, student perceptions are individually analyzed and presented. A "portrait" of what they like about science and how they view instruction then follows as "Student Interpretation of Teacher Meanings."

CHAPTER IV

ANALYSIS AND INTERPRETATION

Introduction

This chapter addresses the main research questions: (1) How do students perceive their school science experience and (2) What does it mean to be a science student.

The chapter begins with an examination of individual respondent perspectives. It seeks to understand and explain each perspective at the epistemological level. In part one, Mr. T's perceptions are organized around three issues: (1) How he views the student-teacher relationship, (2) How he views the curriculum and (3) Taken-for-granted assumptions.

An interpretive sketch for each student is presented in part two. The purpose of this organization is to highlight what each student perceives as the most important issues. Again, epistemological understanding and explanations are sought against a backdrop of experiential themes presented in Chapter III.

The third part of Chapter IV presents the theoretical framework in which the main points of the thesis are presented. Selected themes and issues that students share are discussed. This section seeks to capture the underlying reasons for student perceptions of the school science experience.

Chapter IV concludes with an ontological analysis of what it means to be a junior high school science student.

The main arguments of the chapter are:

(1) Students see the science experience as dialectical.

(2) The teacher is the principal focus of the experience.

(3) Students perceive the teacher as a duality.

(4) Student affirmation by the teacher may be a student priority influencing attitude and achievement.

Mr. T's Perspective

Perspective of the Student--Teacher Relationship

Mr. T sees his experience in the science classroom as an extension of his life in the "outside world". His priority in viewing students as "persons" first and as "students" second is consistent with his perception of himself as a person first and science teacher second. This perspective is manifested in the way he acts towards his students both in the class setting and "in private" where he seems to separate the "person" and "student" in at least one important sense: Mr. T is determined to adopt a positive stance with respect to the "person"; always trying to convey a sincerity, to show concern and to affirm the student-teacher relationship. For example, the researcher observed Mr. T relating the following while giving his class instructions prior to an experiment his students were to carry out the following day:

> The best thing to do to make sure you don't get them (test tubes of air) mixed up is [to] leave them open; but, for the other [test tubes of] gases, sometimes after observing you may want to save . . . [them]. Because if it doesn't all escape you might have a little fun just playing with this . . . [chemical test] at the end of the experiment.

On another occasion Mr. T offered the following advice in regard to student test preparation. In this example Mr. T is speaking the "language of students" in saying something they can relate to and remember. This shows empathy.

> If you summarize and shorten things up and then keep writing things down, I think you'll take it in a lot better than [simply] looking at it. For some reason it seems to bounce off those gray cells if you're just reading it and [alternatively] seems to have to go through and some of it stays there if you're writing or even doing it orally. If you're quizzing each other orally . . . it goes through, penetrates and stay[s] there.

Implicit in the next example is concern for the academic well being of individuals, rewarding those who have done well while encouraging those who haven't done as well. The concern is communicated not so much in words but in the tone and inflection in his voice.

> I'd like to tell you a little bit about the exam yesterday . . . . A 39 and a 38, in . . . [this class] certainly helped but what really helped was the fact that the lowest mark in this class was 18. . . That makes quite a difference so whatever you're doing, you're [doing a good job]. Things are improving quite a bit. If we could only get one or two others now, and they know who I'm talking about so I'll try to avoid looking at them directly for any long period of time, to get those multiple choice marks up.

He sees this positive stance as fundamental to being a teacher, particularly when students come to him with problems which embody the "negative" such as their "being wrong", experiencing difficulty, finding things hard or not understanding. So as to maintain a balanced frame of reference Mr. T consciously stresses the positive attributes of the "person". He wants to like and be liked.

At the same time, Mr. T sees a clear delineation of responsibility for the student as "student." The learner must make the effort to do the homework; that is, become involved in the learning before Mr. T is prepared to engage the "student" with an eye to providing guidance. On two occasions the researcher witnessed conversations involving Mr. T and students who, in Mr. T's judgment, had not sufficiently attempted assignments. The teacher demonstrated great reluctance in offering assistance at that time. He doesn't confuse his perspective of the "student" with his regard for the "person", continuing to like the individual, while at the same time being unwilling to extend himself beyond the parameters he has previously set; beyond the predetermined criteria as to what constitutes an attempt. Clearly, the student must assume responsibility for the learning. Thus, while the teacher seeks to be compassionate, fair and understanding he is not always compassionate with the "student" who hasn't fulfilled an obligation.

Through his communication and interaction with students, then, Mr. T tries to be an adult role model where he is the "person" first and the "teacher" second. He recognizes, however, that this is no easy task when faced with parental concern, and societal "demand", for higher academic achievement.

Perspective on Curriculum

In Mr. T's classroom, curricular matters are not subject to negotiation. Mr. T perceives his responsibility to be one of setting goals and controlling activities so that learning outcomes are predictable. To assist in this regard, Mr. T elects to be at the center of the learning experience; a focus for his students.

> If you're animated to a certain extent you are attracting the attention of the students you're trying to communicate with . . . . [It's] having a bright face and using quick movements that attract attention.

Mr. T sees himself as a highly animated actor who must compete for the attention of his students whom he recognizes as having preoccupations with adolescent personal and social needs (subculture). Mr. T states that

> there are two major preoccupations of kids: those who are non socially active who watch TV or [who] are into sports . . . and those who are socially active. I try to deemphasize social concerns and accentuate science [when social activities begin to preoccupy students].

One can infer that socialization is part of what Mr. T values as a legitimate activity. When the socializing begins to "dominate", however, he is inclined to adopt center-stage and utilize animation even more.

> I maintain that the teaching business is an entertainment business. If you can't entertain them enough to get their interests over and above all the other interests that they have in and out of school, then, you can't motivate them whatsoever.

Even while Mr. T recognizes the need for diversity he is able to keep a high profile. While a third of the grade 8's time and better than one half of the grade 9's is devoted to "experiments", Mr. T offers many of them as demonstrations. They "give kids a break in terms of not having [to hear] a lecture or sit around and discuss and come up with an answer. It's an alternative to the usual." His feeling that students like experiments is confirmed unanimously by student informants.

As "teacher", Mr. T assumes an aggressive stance. He feels attracted to active students, "the doers." In viewing their behavior as positive and in being drawn to them, Mr. T feels he is reinforcing a primary goal for them as "students". The message he hopes he is sending is that science is an "active subject." It involves digging out information and answers for oneself; "getting involved physically and mentally." He validates the lab activities as learning experiences by including test questions based upon the labs.

Mr. T's criteria for determining that student learning has taken place include student ability to formulate answers to questions Mr. T has posed. He expects and encourages his students to: (1) make the effort to "come up with an answer", (2) "consider . . . [the] answer based on what [they] already know [and] (3) put [it] into words."

> If they're not trying to communicate
> back with me, I don't know where I
> stand with them . . .

The process of "considering" implies thinking. In Mr. T's words, students "restructure whatever they were taking in." This further implies "putting [that] into terms they personally understand and relate to." Herein lies what Mr. T sees as an intellectual goal for his students.

> And if they haven't practised trying to conceptualize and come up with answers, they aren't going to be able to do it [on an exam]; if they haven't practised organizing ideas in their own mental framework . . .

To help them organize their thinking Mr. T "builds in" repetition. Moreover, once concepts are identified students are asked to suggest applications. Responses thus serve a multifold purpose. Aside from being answers to teacher-initiated questions they act as an open channel for communication and, for Mr. T, are an important means by which to evaluate student understanding.

Mr. T recognizes that the time available in which to be a potential influence on his students is brief. He, therefore, seeks to integrate life in the classroom with aspects of his world normally hidden, "unseen" to them.

> I try to get kids to see me as more than just a teacher . . . that I am part of the outside world and have expertise there.

When possible, Mr. T recounts, illustrates or reflects upon aspects of his experience as a teacher, father, student and outdoors-person. For example, pictures of his children are prominently featured in his classroom. Mr. T related to the researcher times when he would refer to behavioral characteristics of his young children as a way of "teasing" students who demonstrated inappropriate behavior. The pictures are a visual reminder to both Mr. T and his students that he is more than "teacher" and that curriculum is to some degree fashioned spontaneously.

Mr. T feels compelled to give "recipes . . . to help make kids feel good" which, he says "reflects back, makes you feel good . . . . A teacher needs the good feelings." While Mr. T's "self" speaks through his actions, he stresses the development of the "person" which he says is "just as important as subject matter." Mr. T senses the impact he has on his students when he "personalizes" instruction. "You get back what you give. You hear it back. Other kids from other classes come to me for help [and I hear it from them]."

Mr. T's presence and impact is felt in a more subtle way through curricular materials, booklets which he has prepared for all grade levels of science he teaches. There is no doubt in the students' minds that the teacher is the knowledge authority and expert. This is continuously reinforced through verbal and non-verbal language. Mr. T's desire to be at the center of things is further reflected in his would-be-choice of another vocation; namely, drama or music. As performer and educator he would again be in a position to orchestrate scenarios for pupils.

Because "personal contact is lost when the kids leave the room", the dual nature of his being takes on a deeper significance. There is a sense of aloneness, apartness that the "system" imposes. As students leave the room, already oriented to their subculture, or next class, Mr. T reflects upon the little or no opportunity in which to engage his students until the next time. The students who do visit at noon (there are typically one or two each day for which he is available) usually have remedial concerns or have been asked to come in because of incomplete assignments (Mr. T is unable to spend much time "after school" because of personal commitments). A significant number of his students, then, have infrequent contact with him outside of formal class time. And, as has already been inferred, Mr. T tends to be at the center of activity during class time yielding infrequent opportunities for students to get help or to converse "in depth" on an individual basis. Before school and at noon he deals with many students through clubs and activities. Mr. T believes these are a very important part of his "teaching."

In a real sense this represents a paradox. Mr. T who would like to engage his students more hasn't organized his curriculum to facilitate that need. It appears that Mr. T's perspective or philosophy of education does not allow him to entertain much student-teacher dialogue. When students have their assigned tasks, Mr. T is content to "circulate" and help when called upon or to offer passing comment, rather than to interrupt in order to have conversation. Similarly, during lab activities when the teacher must circulate, he is permitted only brief interaction. There is again a feeling of separation.

Taken-for-granted Assumptions

Mr. T appears to be operating under a set of assumptions that are best understood in the context of classroom dynamics. For example, because his curriculum is inflexible and prefigured, and alternative directions for study are not permitted, Mr. T seems to be communicating the view that science is dogmatic; there is a correct or preferred way of explanation, technique and process.

From his perspective, Mr. T appears to be communicating that his knowledge is most important. Three observations support this contention. First, the main thrust of his courses is his unit booklets. Second, Mr. T chooses the activities that will be carried out. Third, Mr. T dominates with teacher talk affording students little opportunity to be vocal in the large group setting. By his own admission Mr. T has something of importance and significance to impart to students.

Student-initiated experience does not seem to be valued because he does not provide for it. He either does not trust students to make curricular decisions or feels they are not knowledgeable enough to do so. In any event there is no negotiation of the curriculum. As a result, Mr. T feels very comfortable in the situation. The lack of renewal opportunities and his having "made it" as a teacher contribute to the status quo and the presentation of a single perspective of science education.

Mr. T's view of students carries its own set of assumptions. The "empty cup" metaphor seems appropriate as learning centers on fact accumulation. Mr. T believes one of his tasks is to motivate his students. This perceived need may be a consequence of his unknowingly blocking creative problem solving and questioning.

Mr. T assumes a reciprocity of perspectives. That is, he assumes that students experience the same reality or the same sense of meaning as he does; or, that reality is put together in the same way. An indication of this comes through language when Mr. T is queried a number of times by individual students about the meaning of "product." Mr. T finally acknowledges to the class that he just assumed everyone would know its meaning from its context or its common, everyday usage. Mr. T's inclination to give "recipes" is a strong indication that he sees students sharing his values and goals. This is an excellent example of how culture is transmitted through language.

Mr. T assumes that students have, and are able to use, prior science knowledge; that they have developed conceptual maps that will permit them to make sense of new knowledge. Mr. T clearly indicates his awareness of this when discussing student difficulty with the study of metrics. He describes metrics as "nothing kids can relate to."

In the process of socialization, Mr. T communicates a natural attitude (Bowers, 1984) that takes the form of taken-for-granted knowledge embedded in a world view: factual declarations, interpretations or critical perspectives. As such, he communicates objective, reified, reconstructed knowledge, often devoid of authorship or historical, social and cultural context. It appears as "facts out of nowhere" with a sense of permanence and totality. This reflects the way in which Mr. T, himself, learned through the system and developed a dominant world view of culture that includes education. Moreover, Mr. T does not have the experiential base upon which to draw science knowledge and incorporate it into his teaching.

Student Perspectives

Arlene

Arlene raises two significant issues with regard to school science. First, on the question of liking science, she stresses the importance of new activities complete with active participation. She cites examples of film watching, doing an experiment, talking about a new unit and doing diagrams. Newness alone, however, is insufficient to warrant her liking science as when the teacher "just talks all period." She cites boredom "when there's nothing to do." "You're not really into it and you feel like you're missing out on something - misplaced."

The second issue relates to conventional learning of science. Arlene perceives herself to be at a disadvantage with respect to the English language and, particularly, the language of science. Although English is not her first language, she does have a good command of it. She is frustrated by "those funny, scientific words" that "make the subject hard to understand." Their length and unfamiliarity appear to intimidate her. Arlene has rationalized not grasping some of the terminology by stating that she "doesn't care about it" and it's not going to be used "for our future, later on."

Resolution of both issues contributes to Arlene's confidence, being at ease and liking the subject; thus, fostering her bubbly, happy disposition. "I'll concentrate on it and understand and really pay attention." Thus, the importance of the teacher to Arlene's confidence and success in science isn't to be lightly regarded. She identifies "understanding" and "meaning" with the teacher's ability to translate scientific jargon into more familiar language and to ensure that she knows exactly what is expected of her in her assignments.

Barbara

Barbara takes the academic side of schooling very seriously. Her remarks reflect her ability to critically evaluate a learning experience.

> Boring means that something is tiresome. It's repeated or it's something that doesn't apply to you. You can tell right away if it's boring or not.

Barbara identifies five key elements that, for her, establish the meaningfulness of a classroom experience. First, language is crucial to her identifying with the teacher and in trusting him. "He tries to adapt himself so he can talk to you properly. He uses a different vocabulary and tries to make it as simple as possible." Second, Barbara infers that the teacher's delivery is one important way of building a student's confidence in the teacher.

> It sounds like he knows what he's talking about and he's not confused. He explains everything clearly. It's all in one unit; he doesn't break it up and stutter. . . . He says something in a confident voice, not shakey.

Third, Barbara elicits meaning by relating her present situation in the classroom to past experience. She compares "her way of doing it to the teacher's way of doing it. . .[to] see if they're in any way the same." Fourth, the meaning of something is equated to its making sense.

> You think if it's just a good way of doing [something], a smart or reasonable way, or, you think it doesn't make sense and your way would be better.
>
> If it makes sense you understand it and it comes easily.

Fifth, Barbara suggests that the teacher's attitude plays an important role in her assessment of meaningfulness.

> He doesn't put you down if you don't understand something.
>
> The teacher is never boring and we always do interesting things, experiments and stuff.

In sum, Barbara claims that "having the right teacher, a proper teacher, makes things a lot better, easier and more fun. You enjoy doing it. It's something you like to do or want to do." There is a strong indication here that not only is the teacher an important key to Barbara's outlook and attitude towards science but, also, that the teacher has the capacity to dampen the student's enthusiasm and motivation. She implies that the teacher as "teacher" must be knowledgeable, organized and be able to communicate ideas and a point of view. At the same time, there is a flavor of the personal, human side of teaching. The teacher as "person" must be sensitive to individual student needs. The importance of the teacher is focal to Barbara's concept of a good learning experience.

Cheryl

Cheryl believes science ought to be fun and part of an enjoyable school experience. She places a lot of importance on the changing nature of the curriculum - the daily classroom experience.

> When science is fun there is no repetition; the teacher doesn't go over the same stuff . . . . It's change. It's different, something new.
>
> Being excited is trying out different things, new experiences. It's learning to do things in more than one way.
>
> New experiences are challenging. You're learning more things and adding new words to your vocabulary.

The excitement stems in part from what sets science apart, in her mind, from other classes. "I get to experiment, not just sit. You get to try things for yourself." This "independence" contributes to the changing nature of school science as she sees it.

Cheryl entrusts the responsibility for her learning with her teacher. First, he is experienced.

> Since he's had a way more experience than I've had and I'm new at it, I'll trust him. He's the teacher. . . . I generally take the teacher's word for it whenever he expresses his point of view on something.

Second, he explains well and uses animation.

> He'll explain it thoroughly, every way you can look at the question.
>
> It's the presentation, a step by step breaking up into sections so it's easier to understand.
>
> He uses his arms. . .to estimate the length of something. . . .By the way he moves his hands you can visualize the structure in your mind.

Third, he checks for understanding.

> He looks at you to see if you're understanding, if it's getting to you and not going over your head.

While she admits to wanting to learn everything she can, Cheryl confesses that experiences are not always interesting or meaningful. Teacher centeredness, at times, appears to contribute to boredom, frustration and "slacking off."

Doug

Experiments are a key element to Doug's enjoyment of science. He likes the independence, confidence and trust given students, and, contrasts this with the frustration in being strictly an "observer" on other occasions. He cites the importance of interaction with peers while engaged in activities.

> During the experiment with the teacher, there's no chance to talk about outside activities which you can do with friends. I feel like going to sleep. You are watching the teacher do experiments and handle equipment. You don't have a chance to do it [on these occasions]. You have a feeling you can do the experiment by yourself instead of the teacher instructing, doing it for you.
>
> It's enjoyable doing the experiments with friends instead of with the teacher because the teacher is usually boring. I enjoy the way he lets us handle experiments in class. He doesn't often come around and instruct us. You can go faster. I like doing them. I pay attention when there are experiments.

Doug is expressing a need for independent thought. He seeks to exercise responsibility for the learning by indicating a clear preference for self-paced study.

Edward

Edward states a strong preference for "doing" science. He suggests that active engagement with "hands-on" materials fosters interest in the subject and that understanding and "knowing" are enhanced as a result.

> Science is interesting. It's different from regular (other) classes where you just sit all day. It's characterized by action where we do experiments and write reports on them. I enjoy doing it, filling test

> tubes, watching to see what you've done to find out things that happen.
>
> We get to do stuff: experiments, charts; action work that takes more than a day.

The less directed nature of the instruction provides Edward the opportunity to formulate a more complete picture of an event through exploration, idea generation, association, posing of questions and synthesis.

> Instead of just reading what happens you watch what happens. You find out a little clearer. You understand better; that is, you have a better view of things. You know what's happened. You see all of it.
>
> You should understand what will happen next - be able to tell after the experiment is completed.

The teacher's animation enables Edward to follow along and, possibly, affords him greater understanding than that otherwise achieved.

> Sometimes I don't hear everything he says but, because he's actively doing and demonstrating, I'm able to follow the lesson and understand him.

Fred

Two issues rate highly in Fred's perception of school science. First, participation in class activities is most enjoyable when friends are sharing the experience and expectations with him.

> I enjoy science 'cause it's being with friends. . . . Friends help make science more fun 'cause you're doing things you like to do with people you like doing them with. You sorta like to be there.

> I feel good about science class, partly because the whole class does. There are no "goof-offs", people who would hinder other people who want to learn.

Second, the way Fred's teacher presents science sets it apart from other classes in two important respects. It challenges him to think, offering new problems and examples, and, there is a sense of wonder as it relates to chemical reactions, for example.

> It's interesting, not boring like in some classes.

> (Experiments) They're neat 'cause reactions turn color and they're spectacular. Things burst into flame; I like this sort of stuff. It's kinda neat that you can do something like that. You can put two innocent things together and then it makes some kind of reaction that's pretty spectacular.

> The experiments are all new stuff so you don't get bored because you've taken it before. We do things that are fantastic, awesome.

> There is a feeling of wonder as with experiments.

Some aspects of the instruction, however, are clearly less interesting.

> When he's talking it could be interesting but not all the time.

> When you just have to sit and absorb

> [material] as in a lecture then it's boring.
>
> Boring things are those that I'm not interested in such as tests and lectures, or, those that I've already done in other courses which have lost their interest. You've already heard all about it; all the wonder has gone.

For Fred the bottom line is that he feels good about science and that he is learning. He feels he is being challenged intellectually. He credits his teacher with providing the ingredients for a worthwhile learning experience.

> I feel good that I'm learning something, picking up a lot of information. He's a pretty good teacher.
>
> (Experiments) They're fun 'cause they involve more mental work rather than paper work.
>
> [My teacher] expects me to think first, not guess, and come up with answers. After a question he would say 'think about this.' This would be . . . your key.

Greg

Greg sees science class as distinctive insofar as experiments are concerned.

> I like science because of the experiments. They're different from ordinary schoolwork where you do a lot of reading and writing.

Greg is conscious of the utility of the topics studied. His remarks perhaps reflect his teacher's attempt to portray science as "relevant" to the everyday lives of students.

> I want to learn more about science 'cause it could probably help you in the future. Like when we took weather. When I'd watch the news [on TV] I wouldn't know what HIGHS and LOWS were, but now I understand it.

Jerry

The key to Jerry's positive attitude towards classroom science is his teacher, Mr. T. Rather than always being predictable or acting as a bearer of facts, Mr. T. varies his approach which creates considerable interest for Jerry.

> You learn stuff you didn't know before.
>
> It's neat doing experiments 'cause you wonder what's going to happen next. It's often a surprise. For example, earlier this year the teacher inserted a burning splint into hydrogen gas and produced a loud pop (minor explosion).
>
> You're sorta curious when he's talking about interesting things, something special or something he feels you need to know. You're wondering what he's gonna say next.

Jerry believes Mr. T. seeks to encourage independent thinking and to improve thinking skills generally.

> He wants us to reason things out; look at all the different things and come to a conclusion of our own so as to know what we're talking about and whether or not it's right. By saying "so?", "so what?", "who cares?" and "tell me more about it", he wants us to specify more our answers to his questions. It serves as a check on our knowledge.

Kathy

Kathy likes the novelty of the activities in science and finds this aspect of school science the most rewarding.

> It's interesting, doing some of the experiments we do, the way the group sets it up and the way we do it. It's something I've never seen before. It's interesting to find out what's gonna happen next.
>
> It's exciting when we do experiments, like we did one time when we had to fill test tubes with water. That was fun, something I've never done before. Techniques such as using balances are useful and kinda fun.

Her not being in this school last year and having missed some aspects of previous study has, in Kathy's mind, put her at a disadvantage. She has found it difficult to get the kind of help appropriate to her needs. This has had a substantial bearing on her perception of the experience.

> When I don't understand, it's boring. Once we had to do a unit by ourselves with no help from the teacher. That was hard. Most of the time when it's hard it's boring.
>
> I had missed some work from previous years but couldn't arrange to get help from the teacher. [I could come in only after school and he couldn't stay after school.] This made it hard.
>
> At times I am confused in class. Sometimes I don't understand what he's talking about.

> I guess this is one of the reasons I'm really doing bad. When I am confused I feel that I'm not part of the class or something. I ask for help and nobody helps me. When I have difficulties I'm scared someone is going to find out. So I find it difficult to go after help; I just never do.

Laura

Laura's perception of school science reflects the "personal" impact of her teacher, felt both at school and at home.

> He is facially expressive. He looks into people's faces. I ask questions when I don't understand. He knows I don't and kinda winks at me and smiles. He'll stop and explain [something I don't understand].
>
> When I do my science homework, I feel he's right there talking to me. When I'm reading over something I kinda hear his voice, the way he talks and emphasizes things. Picturing him talking helps a little bit. I think about it more clearly.

The impact of her teacher is further felt in that part of the course she admits to really enjoying: experiments.

> I like science experiments and different things to do. When we do experiments he lets us go on our own, in groups. You feel like you're your own special scientist. He doesn't baby sit you. He tells us what we're going to be doing and then let's us be on our own.

It is clear Laura's remarks reflect her desire to be given some responsibility, independence and opportunity to move about - be physically active. This is supported by comments which address the issue of having to listen to lots of teacher talk.

> When I am tired or when it gets boring I want to be excluded. I don't want to listen to what he's saying. Sometimes it seems the class is really long like the last period in the day. If it's the afternoon, [science] gets tiring.

Martin

Martin finds that much of his attention in science class is directed at the teacher. He has a positive feeling about what the teacher is attempting to do to help him and other students learn.

His teacher is sensitive.

> He doesn't get mad when little things go wrong. He gives you a second chance. He doesn't put you on the spot by asking you questions you can't answer.

His teacher gives advice.

> Occasionally, my teacher will tell us about some of the things that he did wrong which I, as a student, might do wrong. He tries to help us by relating his experience. You might go through what he did so he wants you to know what to expect.

> When my teacher is giving advice I get a mildly positive feeling.

His teacher explains things very well.

> My teacher makes himself believable and convincing. He says what he thinks and what he believes. He's outspoken; he explains things as he talks.

Nancy

Nancy enjoys a fast-paced lesson and the independence and responsibility for learning that comes with doing experiments "on one's own."

> You're not doing the same things over like in language and math. You can do experiments and discover things yourself rather than having the teacher tell you what's going to happen. You can find out for yourself.
>
> You see it happen better and remember it if you do it. This helps your understanding . . .
>
> Experiments are interesting to me; you're discovering something new. For example, we worked with rocks, checking for hardness by grouping them and finding what kind of rock each is.

Much of the time, however, students are not engaged in lab work and the teacher is often talking for much of the period.

> We just watch him but sometimes we're bored. Well, see there, he's talking about the same question for a long time. He'll go over stuff and I'll understand it. But if he reviews then it's 'unmeaningful.' I already know it; it's in your mind.

Interpretation of Student and Teacher Perspectives

Socialization and Teacher Control of Meaning

Outside school, students learn a process of socialization in context. They learn, for example, to maintain the proximic space in different social settings. They do this well for there is punishment if they do not. Students learn this taken-for-granted, embedded kind of knowledge without technical words and concepts. Much of culture is learned implicitly including complex repertoires of cognitive behavior and emotional responses that may be used without conscious awareness. Where students get their meanings is, in part, something they are not aware of.

Schutz (1962) suggests that what individuals learn has a lot to do with the conceptual framework they bring to the moment of cognition. Past socialization gives them a certain language framework that enables them to extract meanings from things they read or hear. They have a means to understand or make sense of those things. Embodied in language is the epistemological framework of the culture. Their language helps structure how they learn; more specifically, their thoughts. In learning new knowledge, the mind reorganizes and enhances that framework; it does not "grind up" the information that it perceives. Thus, the ability of students to communicate what they have learned is embodied in the vocabulary they use to explain aspects of their world. Language, then, is an important tool of the socialization process.

In school, words and concepts are the intended chief medium of the message. It is a symbolic interaction that goes on between teacher and student. The teacher makes available the initial vocabulary, including embedded conceptual maps, about that part of the culture the teacher is introducing. A lot of things that a science teacher talks about, however, may "go by the boards" because students can not understand them in terms of the conceptual framework they bring to the setting. Moreover, students can not know about them if unaware of the structures of their own language.

Given that students see Mr. T as a significant other, there are three ways in which he might exert control in the socialization process and, thus, over the students' communicative competence. First, the words, concepts and explanations that Mr. T offers students, and takes for granted, may "stabilize" what the students may already have experienced or "know." These may limit the students' communicative competence in the sense that they simply overlay the students' taken-for-granted world. Paradoxically, these may deny students the opportunity to be part of culture. This situation may well promote student boredom as when

Barbara suggests that boring is "something . . . tiresome" and "repeated."

Second, students may learn words and concepts in science in the absence of context. They learn in the abstract, without reference points in their own experience, then forget. Lack of context may contribute to boredom as when Barbara remarks "It's something that doesn't apply to you" or when Fred comments "When you just have to sit and absorb [material] as in a lecture." In this circumstance where students are "hearing for the first time", they are unlikely to challenge the teacher. If they do ask questions, the teacher will likely meet the challenge at some higher level of legitimation. Students learn that they need not question and may resign themselves to being bored.

Third, Mr. T could choose to give students the symbolic basis for very complex thoughts that enables students to see things not previously seen. Here, Mr. T would be sensitive to students as carriers of cultural knowledge. He could bring out the taken for granted using a variety of information sources. By using descriptive accounts of students and others, Mr. T could work towards developing a more complex vocabulary and set of concepts for understanding that part of the cultural experience to which students can relate. Greg's comment illustrates the potential of this means of controlling the socialization process:

> I want to learn more about science 'cause it could probably help you in the future. Like when we took weather. When I'd watch the news [on TV] I wouldn't know what HIGHS and LOWS were, but now I understand it.

Nancy's comment is also illustrative of the process:

> Experiments are interesting to me; you're discovering something new. For example, we worked with rocks, checking for hardness by grouping them and finding what kind of rock each is.

By providing students with a concrete reference to past experience, Mr. T is helping make explicit taken-for-granted knowledge about rocks while promoting Nancy's communicative competence.

It is clear that what Mr. T explicitly communicates about science through demonstration and "discussion" is a highly reconstructed and objectified picture of science. For example, Mr. T spells out in great detail events and explanations associated with the demonstration. His students acknowledge that he explains things well. It is also apparent that both Mr. T and his students are aware that much is communicated through body language and indirect reference. For example, when Mr. T remarked that "now if we can just get one or two students, and they know whom I'm talking about so I will avoid looking at them for any length of time, to bring up their marks" he may be trying to motivate the entire class while at the same time "pressuring" the lowest achievers to improve.

From the interview data it is apparent that Mr. T is controlling the socialization process in each of the three ways described above. Yet, during the researcher's presence Mr. T's principal means for control is through abstraction and lack of context. An assumption, then, might be that students are not formulating perceptions about science beyond the content presented. This may be flawed, however, as students simply may not be able to verbalize them in cognitive terms. Rather, students express feelings about school science in terms of how the experience is meaningful in light of their prior knowledge.

The power of implicit knowledge that students carry enables them to make appropriate responses in learning situations. If, however, the situation introduces unfamiliar words, concepts or patterns, it can promote frustration and difficulty in the student's mind. In the present study, frustration is part of the school science experience as Kathy relates:

> At times I am confused in class. Sometimes I don't understand what he's talking about.
>
> When I am confused I feel that I'm not part of the class or something.

Arlene comments that "the scientific words make the subject hard to understand. . . . I can't understand those funny, scientific words. They're long and don't tell you the meaning." She indicates that science can be her favorite subject but doesn't like it "when it's hard to understand as when there's scientific words."

Cheryl suggests that science can be frustrating at times. She remarks that "if you don't understand something and he goes over it and you still don't understand, it gets frustrating."

It may be, as many educators suggest, that a certain amount of frustration necessarily accompanies the learning experience. Previously learned habits or patterns may constrain students. If the process of education is to make explicit some of the implicit language, conceptual bases and theory frameworks, then the teacher's task is to mediate that process. The teacher has the potential for bringing these patterns to the conscious level.

Thus, there may be an ideological conflict that gets played out in the science classroom where Mr. T is coming from a point of view that science knowledge is objective; complete with a whole set of epistemological assumptions that underlie the inquiry process. The natural attitude of students, however, reflects meanings derived from implicit aspects of knowledge. The intensity of this conflict is made problematic because, as Rowe (1977) has determined, students are struggling with issues of identity and self concept.

Student Interpretation of Teacher Meaning

Since individuals are continuously involved in interpretation and sense-making for their experiences, Merleau-Ponty (1962) decribes them as "condemned to meaning." Science students interpret what goes on in light of their own interests and intentions. Interpretation of the "same" situation varies from person to person - each experiencing it differently and perceiving it differently. Because students communicate and share perceptions that, in turn, may be incorporated into their own frames of reference, it is entirely possible that many elements of a situation would be shared. It is, therefore, important to draw out common aspects of these individual experiences in order to illuminate the everyday world of experience with its meanings intact.

To understand common meanings students have for a given experience, it is useful to recall what they like. Some aspects of a "liked" experience shared by more than one student include the following: having a good teacher, having a variety of things to do, being able to work on one's own or in groups, knowing that you can do things, feeling special, doing diagrams, receiving new information, and being able to experience something that makes sense. Students describe a good teacher, for example, as one who explains things well. If the teacher is not able to communicate, difficulties may draw the student "across the line." What the teacher is trying to communicate, then, becomes hard to understand. The student may interpret this as not liking the experience.

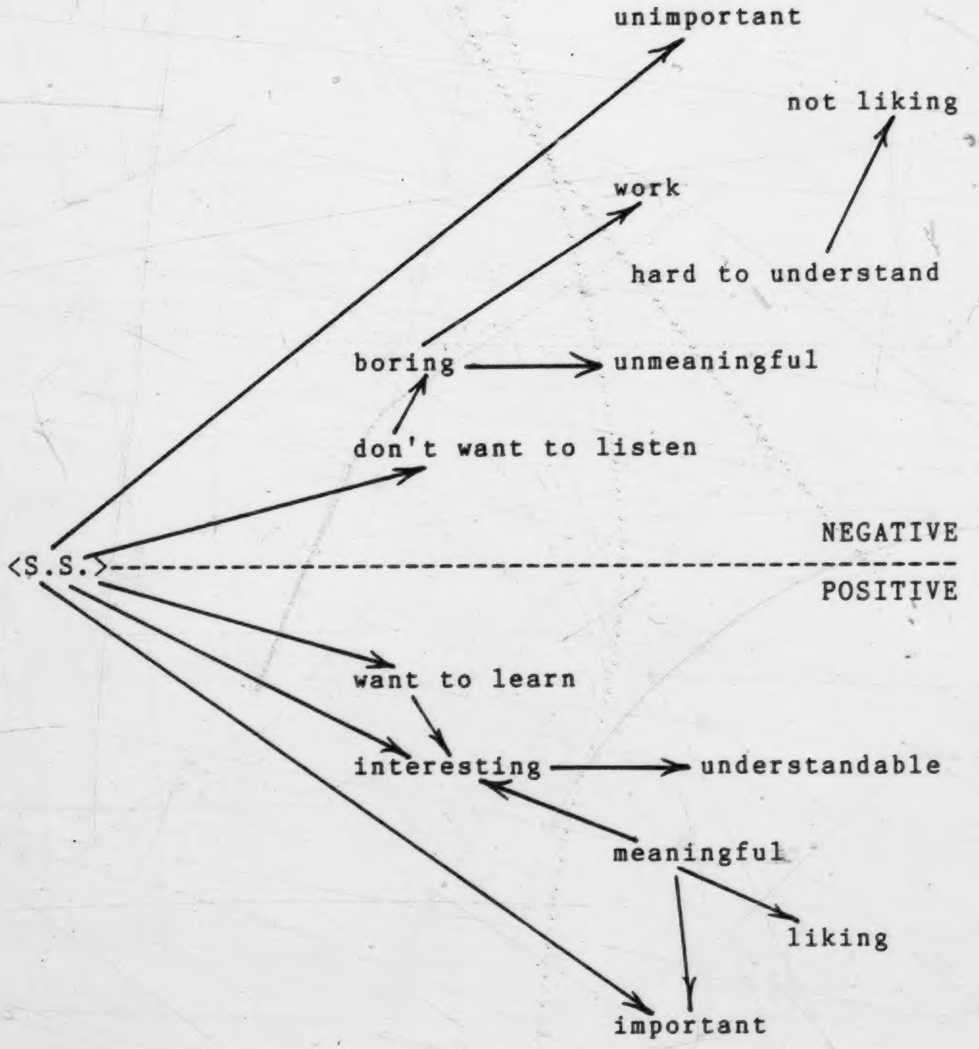
Most students view their school science experience partly in positive terms and partly in negative terms. On the positive side they describe their experience as interesting, liking science, knowing, understanding, important and meaningful. This is "balanced" on the negative side by references to the experience as work, boring, uninteresting, hard to understand, not liking, not making sense, wrong. These students seem inclined to contrast a positive descriptor with a negative one. Thus, if an assignment is not "interesting" it may be seen as "work." Or, if it is not "understandable" it is "boring."

It may be that students view a given lesson using a standard represented by a sliding scale model. At one end lie criteria that, if satisfied, designate the experience as positive; at the other are criteria that, if satisfied, lead the student to an interpretation of the experience as negative. What seems clear is that many students are conscious of knowing what is "preferred", or "better" because they possess and use comparative knowledge. They are able to express what is a "good" experience because they have, what is for them knowledge of what is a "bad" one.

A few students appear to consciously judge their experience in class as the lesson progresses. For example, one student indicates that she "knows the importance" of what is transpiring. Another knows whether or not the lesson concepts and facts are already a part of her knowledge. A third student's experience of boredom entails, in part, a conscious withdrawal from teacher meanings, an interpretation in keeping with Spindler's (1963) description of boredom as an "emotional and intellectual separation from the environment (p. 211)."

Thus, in their search for meaning, students are often able to speculate on descriptive relationships. Many students suggest what "better science" is or what they think it means when they are "good at something." Therefore, within the context of a positive or negative perspective it is possible to consider interrelationships among descriptors. When something is "hard to understand" it is "not liked"; if something "doesn't make sense" it is perceived to be "wrong"; if it is "interesting" it is "meaningful to me" and, therefore, "important." It is often unclear in the student's mind as to what comes first in the relationship.

Perceptions are often "understood" to be synonymous. In other cases a circularity is expressed. In one instance, a student comments that something she likes is meaningful for her while, "at the same time", the meaningfulness of something leads her to like it. Figure 1 illustrates these interrelationships while emphasizing the positive-negative dichotomy.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don't want to listen
NEGATIVE
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POSITIVE
want to learn
interesting
understandable
meaningful
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Figure 1. A positive-negative dichotomy of interrelationships describing student perceptions of school science (S.S.).

Dialectical Nature of the School Science Experience

Students seem to perceive their science experience as a dialectic. Not only do they see their experience at times as positive or negative but, also, are able to "simultaneously" visualize a contrasting experience. When Laura expresses a liking for science as in "He lets us go on our own, in groups and stuff", she quickly adds "You don't sit there. He doesn't sit there and hold your hand. Like in elementary [school], they're right over your shoulder telling you what to do." Laura holds contrasting "pictures" of more and less favorable experiences.

Fred supports Laura's perception indicating that being a science student is an enjoyable experience. "I enjoy it. . . . You're sorta interested; you're not bored like in some classes. You sorta like to be there."

Arlene seems to be indicating in her comments a preference for learning through spatial relationships and visuals.

> Well, I like it 'cause when we do diagrams and all that . . . but I don't like it 'cause it's pretty hard to understand. They have all these scientific words in there.

Brenda is able to distinguish Mr. T's different intents. For example, she states:

> You can tell in his face that he means it as part of the lesson and not just as a joke in between, or . . . just to break the mood or somethin' like that. . . . If he would have been laughing or smiling . . . you don't believe [him]. But [Mr. T] wasn't doing that. He was just talking as though it was a conversation or just his normal teaching methods.

Cheryl perceives school science to be:

> a whole lot easier and a lot more fun . . . if you have a teacher who's really interested in the subject and he's not just there 'cause he has to be there. He can relate to the kids; he can understand their problems and frustrations.

She adds that "It's fun because you don't keep on going over and over the same things again." Her comments seem to imply that she has experienced teachers who exhibited contrasting characteristics and methodologies. Her characterization of Mr. T is made possible because of this past experience she holds in consciousness. It is also part of her tacit awareness of what is better or preferred.

Greg describes homework in terms of "opposites." "Sometimes it's interesting and sometimes it seems like work. Half and half." These experiential categories likely reinforce Greg's dialectical thinking in that he will probably anticipate homework as being either "interesting" or "like work" prior to making a final judgment about a given assignment.

Because students are capable of evaluating the learning experience during the course of a lesson, they may well view Mr. T's actions in a dialectical relationship with their preferences for curriculum-as-practised. A student, for instance, may have a personal need to ask questions, tackle a particular assignment, or work with another student on a project. On the other hand, Mr. T may be concerned with the needs of the group as a whole. He, therefore, spends the entire period demonstrating techniques for an upcoming investigation or correcting a previous assignment. The student may not be interested and feel bored; feel that Mr. T is simply "baby-sitting." Many students are reluctant to interrupt Mr. T preferring to speak with him before class or after.

> I won't ask questions in class. I'll only ask my teacher if I'm really confused and then only after class.
>
> During the experiment with the teacher, there's no chance to talk about outside activities which you can do with friends. I feel like going to sleep. You are watching the teacher do experiments and handle equipment. You don't have a chance to do it. You have a feeling you can do the experiment by yourself instead of the teacher instructing; doing it for you.

> At times I am confused in class. Sometimes I don't understand what he's talking about. . . . I ask for help and nobody helps me. When I have difficulties I'm scared someone is going to find out. So I find it difficult to go after help; I just never do.

> If you need help or something, you just go to him and he'll explain it. He'll spend time on you when you want. . . . He'll say "If you want to come in for help, feel free to come and see me."

The student's desire for academic excellence and performance is in dialectical conflict with the teacher's desire for equity of treatment - group needs as opposed to individual needs. As he is unable to accommodate the potential needs of each student in the group setting, Mr. T plans the situation and manages it through domination.

In the student's struggle to satisfy personal needs and to ameliorate external and self-imposed pressures, Mr. T is for 40 minutes each day, a "possibility" where he could permit students some "independence" through activity instead of "dominating" with talk most of the period.

Given that Mr. T sets the agenda and students are relatively attentive, unencumbered by their own agendas, Mr. T's positive impact is a reflection of the degree to which he dominates the lesson through talk and demonstration. In this mode his effectiveness is a function of how well he explains events and concepts. The care taken to anticipate student problems with language used helps to remove "unnecessary" difficulty.

Student perception of Mr. T as teacher is complicated when students have not completed homework or are about to write a test. The few students who make reference to these tasks suggest they would rather not go to class as they fear the consequences of being found out or of doing poorly. In addition to not wanting to risk their status as student or their self-concept, students wish not to incur the "wrath" of Mr. T. While he is considered fair, students know that "he is the teacher" and they have responsibilities as students that must be met if they are to receive help or succeed.

The Student-Teacher Dialectical Relationship

Students know there is a personal side to Mr. T. They candidly speak of his charisma, voice, facial gestures, eye contact and body movement; personal characteristics and mannerisms that are perceived as personal communication. For instance, students comment that Mr. T uses voice emphasis and modulation to indicate the importance of the concept, in addition to the nature of the concept itself. By contrast, when they speak of him as a good teacher they usually make reference to an "academic" behavior such as explaining things well.

Students value Mr. T as person. Here, too, Mr. T is seen as a "possibility." The value students place on these qualities may be explained by the students' need for affirmation. Each student, as person, shares the need to be liked; to be accepted. Students need to have this knowledge early and have it reaffirmed from time to time. The extent to which this affects student achievement is uncertain. It is clear from research, however, that many students do not achieve commensurate with their potential. Some of those students claim not to work for a teacher for a variety of reasons. An important consideration is whether or not their teacher affirms them as individuals - as persons. Part of the teacher's success appears determined by the degree to which that teacher risks vulnerability in exposing the personal side. Of the teacher, Hall (1976) writes:

> He must build relationships . . . make himself real, and allow time to take on substance as a human being, to be believable . . . before he tries to do anything else. (p. 44)

Hall (1976) suggests that a common pitfall for teachers is that they pay too much attention to subject matter and too little to their students. Hence, these teachers provide "low-context" experiences for students, assuming little about students and making most information communicated explicit. What Hall may be advocating is that teachers strengthen relationships with students. In forming good relationships it is then possible to move to "high-context" situations where most of the information transmitted is "in the physical context or internalized in the person (p. 91)." This seems plausible as students tend to pay more attention to the teacher than to substantive issues of the subject.

No doubt students learn to seek affirmation or acceptance as part of the school experience. A student's willingness to perform for a teacher may be explicitly stated in terms of what the teacher provides by way of instruction and classroom management. Yet, it is likely that this willingness is implicitly determined by the teacher's acknowledgement of the student as person.

Student Perceptions of "Being a Science Student"

When students are asked "What is it like to be a science student?", most offer specific comments about Mr. T. The remaining students make specific reference to hands-on activities. It is clear that Mr. T is an important focus of the school science experience and is implicated in all aspects of curriculum-as-practised. There appears to be close agreement between student perceptions and those of Mr. T as to Mr. T's participation.

Mr. T's centricity in the students' school science experience is confined primarily to the classroom and to occasional personal contact in the school building before school, at noon or after school. Most students do not see themselves as science students once they leave the classroom despite the fact that they all do homework and study for tests. One student states that she visualizes Mr. T while studying. This probably helps her contextualize the material on which she is being examined. Two students remark that they are inclined to perform activities at home if those at school are exciting. Another student comments on making an association with information seen on television and that studied in class. Mr. T is not mentioned in these latter instances.

The strong association of school science with Mr. T probably explains why science is viewed only in the context of the classroom. The science experience of the classroom is under Mr. T's direction. However, Mr. T is not part of the "real world" context. Specialized knowledge and language are usually not part of conversation in non-school social settings. The content of the student subculture typically does not include reference to academic concepts and language except, possibly, as a focus for humor.

Much of the hands-on materials and equipment that are used in the junior high school science curriculum is not present or readily available in social settings. If student perception of school science focuses on teacher talk and activities with lab equipment and materials, it is unlikely that students would easily associate the "science that is all around them" with the classroom experience. The objectified, reified and decontextualized science of the classroom is perceived as a compartmentalized piece of student reality.

Within the context of the school, students perceive school science as special, distinct from other classes.

The principal reason for this is the experiential component: hands-on activity. Allied to this is the acknowledgement that Mr. T is the one responsible for providing "experiments" for students to carry out where students can get up out of their seats, move around and talk with one another. Students also note that some of the demonstrations in chemistry units produce surprising and dramatic effects. In contrasting previous years' science classes with the present one, a few students are quick to note previous ineffective teacher explanations and an absence of lab investigations.

Teacher As A Metaphor For Science

The problem of how students perceive the experience of school science is one of seeing themselves in others, specifically the teacher. This neither presumes a reciprocity of perspectives nor does it presume the sharing of a common propriospect (Goodenough, 1981) of beliefs, values and attitudes. The idea of seeing oneself in the teacher is having the language (or being given it) to understand where the teacher "is coming from." Making sense of the teacher in the school science experience is understanding the teacher's frame of reference. The teacher is the context for understanding the teacher as "person" and as "teacher." As such, Mr. T is the curriculum: the intent, display, activity and evaluation of the experience. Where Mr. T, himself, is not the activity, he helps orchestrate it. Student willingness to participate may be a function of Mr. T's affirming that student as "person" and his demonstrable caring and fair play.

What It Means to Be a Science Student

Understanding the nature of the school science experience and the meaning students have for it, is aided by the perception of the experience as an extension of student reality. Any meaning that students have for their school experience is made possible from having lived, and by continuing to live, in a culture and from having been socialized in that culture. Schooling is part of that socialization. The culture not only equips students through language to make sense of their school experience but, also, shapes the sense-making process. Much of this is done implicitly.

Students carry with them as part of their historical baggage, expectations and assumptions about future subject classes in school. They possess considerable tacit knowledge that undoubtedly influences their perceptions of an experience and the meaning they assign to it. What should not be assumed is a reciprocity of perspectives with their teachers as suggested by Schutz (1962) and Edwards and Furlong (1978), at least in regard to person-person communication. Instead, students may be seeking out the teacher's frame of reference, one that embodies a belief system and a set of values and attitudes. Students are interested in who the teacher is as a person.

The enculturation process provides students with a propriospect comprised of elements making up their "operating culture": forms, propositions, beliefs, values, recipes, routines, customs and traditions (Goodenough, 1981). Goodenough's notion of propriospect is centered around the issue of implicit standards that individuals attribute to these elements. In their perceptions of another person, individuals react to behavior (an expression of culture) that manifests these standards. Individuals are inclined to interpret another person's beliefs and values that are embodied in an action.

Thus, student beliefs and values may be juxtaposed with those of their teacher. Student perceptions of a teacher and, therefore, their classroom experience may be a function of how willing students are to accept the teacher's implicit standards, as students individually interpret them, at least temporarily. This willingness may, in turn, be premised on how well the teacher communicates affirmation of the student's operating culture.

Part of the socialization process appears to be the teacher's tacit "acceptance" of the student - an affirmation of student as person. Being a science student may be implicitly searching for affirmation first, and explicitly seeking science knowledge second. At the preconscious level students may be looking for a support system. If they are part of a "social" subculture, a support system may already exist insofar as the "person" is concerned. If they are "loners", students may look to the teacher as a principal source of support, at least while in school. All students may look to the teacher for tacit affirmation of their "person" as a prerequisite to the "student" learning the concepts and factual knowledge of school science.

It is hypothesized, then, that teacher affirmation may be critical for optimal student attitude and achievement. Everhart (1983) concludes that about 10% of the student population in a junior high school may be active resistors. Those students whom he studied and who reflected this segment of the student body, may not have perceived this affirmation and, thus, chose not to perform to their potential. The reason Mr. T's students do not appear to be actively resisting may be that Mr. T through his "person" and his being a "possibility", is taking away the "seeds" of active resistance.

Instead of Mr. T articulating to students the merits of the subject under study or the importance of learning particulars, he need only affirm students as persons. Once affirmed, students may thrive on good-to-excellent teaching or may accept and tolerate average-to-poor teaching. In both instances students can only "accept" the curriculum when they haven't been given the language to challenge it. They are in "awe" of the teacher's experience and see themselves in a subordinate position. There is some sense of equity only when they can be their "own special scientist."

Therefore, being a science student is being a person first and student second. Students want to be acknowledged as persons and to "touch base" with the teacher as person. This is consistent with the way Mr. T sees himself in his interaction with students. At the same time, students are careful about being the teacher's pet. They are very conscious of peer norms and codes for acceptable behavior.

Michalko (1984) argues that part of the anticipatory character of adolescenthood is the trying on of social roles. He describes the transitory nature of adolescence as a preparation for "specialized work" characterized, in part, by the "uncertainty of the adult roles ahead." He describes adolescenthood metaphorically as "developing and anticipating wholeness and completeness" in the midst of physical revolution. Being a science student is part of that metaphor. It is partially fulfilling intellectual and social needs through hands-on activity, sharing, cooperation and verbal interaction. It is anticipating newness and the changing face of curriculum.

Being a science student has a dual nature. It is being both a student and an adolescent. What it means to be a science student overlays the taken-for-granted background character of the "school" experience where students carry with them all the tacit knowledge for handling school routines and behaving according to school norms and idiosyncratic rules explicitly given for specific classes by individual teachers.

Can "being a science student", then, be isolated from "being a student" either in school or in another class? Barbara's comment suggests that students make important distinctions among classes and teachers:

> You have to get to know each teacher individually and adjust yourself to each. You consciously change your way of thinking for each teacher.

Being a student may mean being intellectually "in phase" or "in concert" with the teacher. In the cognitive sense, then, being a science student may be no different from being a student in another class with a different teacher.

On the other hand in Mr. T's science class, students experience a tension between activity and passivity. Conflict may characterize a student's dialectical perceptions of classroom life not unlike that in the "outside world." The school science experience, then, is a reality of its own; consistent, in part, with the reality of the world outside.

CHAPTER V

CONCLUSION, RECOMMENDATIONS AND REFLECTIONS

General Conclusions

To understand the experience of being a science student researchers are compelled to let students speak for themselves, that they may recount their pre-reflective classroom experiences. It is hypothesized that the lived-experience of the science classroom parallels that of life itself especially for young adolescents who are caught by the pull of childhood and the push of adolescenthood. These junior high school students may share a restlessness - an eagerness to grow into mature adolescents while clinging to the "security of childhood." This may be experienced as a conflict of emotion and need, typifying a duality in living the school science experience.

Past socialization equips students with taken-for-granted cultural knowledge, a repertoire of behaviors and a set of expectations. Out of this milieu emerges a verbalized perspective of school science that exhibits little diversity among students. Furthermore, junior high students may experience school science as needing to belong; needing support and assurance; needing to do well academically - to please at least parents and the self, if not the teacher.

Students have implicit standards, shaped by language and experience, that are not dissimilar from one another. They use these standards to cognitively evaluate or judge the worth and merit of the school science experience. Student comments about their teacher often stray from those typifying teaching to ones describing the teacher as "person." When students comment that "He's nice" or that "He tells jokes", they seem to attach major importance to it. The dialectic of viewing the teacher as "teacher" and as "person" may be an important basis from which to evaluate the teacher as "good" or "bad" and to identify with the teacher or not. Moreover, this set of lenses may enable students to decide the "quality" of the science experience and, ultimately, their knowing how successful the experience has been for them. When it becomes apparent to students that the teacher is acting positively toward the student as "person" then "he is the teaching."

When Edwards and Furlong (1978) argue that students suspend their own meanings in favor of seeking out those of their teacher, they do not seem to take into account that societal influences continue to forge in adolescents a dialectical stance toward their experiences including social relationships. There are not only competitive forces directing what students attend to (peer group, TV, video, schooling) but, also, enculturating forces that "pressure" students into making judgments about everything they do attend to. Thus, students and teacher carry with them as part of their propriospect a duality - an orientation toward judgment as to what is good and what is not, what is right and what is wrong, what are perceived to be wants and needs and what are not, and what is attended to and what is not. This orientation is a predisposition for students to "quickly" evaluate or "size up" a situation; to judge the teacher's performance at explaining and making sense.

Students also feel the science experience. They live it. These feelings are expressed dialectically. The ordinary meanings students have for the school science experience are framed by an either/or, black and white way of looking at the world. The experience "contains" elements that appear to offset the taken-for-granted character of school life such as handling different materials and different pieces of apparatus. There may be opportunities for social intercourse and gross motor movement within the classroom. These may be viewed as first order epistemological differences from those activities in the language arts or mathematics classroom. What is more difficult to observe are those implicit communications the teacher initiates and those meanings students ascribe to teacher actions. These serve to equip students with powerful arguments for deciding whether or not to participate in whatever curriculum and learning atmosphere the teacher chooses to establish.

Student descriptors for the school science experience suggest that early in the term students develop an affective-cognitive "map" shaped in part by an emerging positive/negative dialectic. As students begin a class at the beginning of a term, there may be a "thin line" separating what seems to be a positive experience from one that is negative. In time, the map "crystallizes" a network of descriptors. The more that students perceive the experience as either positive or negative the more these descriptors seem "real." A predominantly positive or negative perception of the science experience emerges as more descriptors become associated with one perception or the other. As one of these perceptions is strengthened, it may become difficult for students to shift to the "opposite" one. The links become self-reinforcing. For example, once students associate difficulty with frustration, boredom, passivity and/or a perceived lack of success, their motivation will likely drop and student-teacher interaction wane. At this point it may be too late to effect change in student attitude.

Thus, for student perceptions of what it is like to experience the subject of science, there emerges a cognitive-affective verbalization of what meaning students attach to the experience. It is defined for them "in fields of contrast" (Taylor, 1977, p. 110); in a dialectical world which is not only bound up with the "level and type of culture" but, also, with the individual's subjective view of the world.

When students perceive the lived school experience as relevant it may be because teachers affirm their students' identities and individualities. Teachers often view students at a distance as "something out there." The junior high school teacher who ignores the student as "person" runs the risk of "losing" students who are not highly motivated toward curricular tasks. Whatever motivation students bring to the class may be lessened through perceived teacher neglect of the student, lack of caring or unfair practice. A teacher who affirms the "person", who shows genuine interest in students, who encourages cognitive and affective growth of the "student" (and "person"), and who acknowledges the "reality of adolescenthood" can at least maintain that motivation, if not enhance it. To do less may in some way establish "blocks" to teacher meaning and to learning. To do less may create the "artificial" need for teachers to extrinsically motivate students. This could be interpreted as compensation for perceived teacher oversights or shortcomings and for the taken-for-granted character of the teaching.

With respect to the views expressed in the literature surveyed in Chapter II it appears that Mr. T's curriculum-as-practised is representative of many of the "problems" associated with science education in schools today. Nonetheless, there exists an established rapport between Mr. T and his students. Students share many common meanings as Mr. T speaks a language that his students willingly accept; a language that often communicates a taken-for-granted view of school science. Because Mr. T "addresses" the student as "person", however, students do not resist.

Educators and researchers need to seek out, examine and question commonly-held, taken-for-granted assumptions implicit in the language and practice of science instruction. Major assumptions include:

1) students reserve judgment of teacher meanings
2) students must set aside their personal knowledge and history, and suspend their own meanings in favor of entering the teacher's meaning-world
3) student interests and wants are secondary in the learning process
4) students are not sufficiently skilled at decision-making or in assuming more responsibility for their education
5) the process of science is associated with a single world-view.

Any of these may contribute to an inordinate reliance on teachers where students are imprisoned socially and misled with respect to the essence of science as inquiry. Assumptions such as these may be the root cause for curricular practice that is antithetical to the needs of students during early adolescenthood.

Recommendations and Suggestions for Future Research

In suggesting to educators courses of action by which to improve the quality of the school science experience, it is important to contextualize any action within problem boundaries. For example, it is clear that, in their teaching, educators will not address the issue of taken-for-granted assumptions with students until they, themselves, have accepted the possibility of their existence. In light of this, it is recommended that pre-service and in-service teacher education programs adopt and vigorously defend a more critical orientation to science education practice. This may include presenting science as an historical reconstruction of alternative views and perspectives as opposed to the logico-positivistic, reconstructive model that pervades science curricula today. Also, a critical orientation to educational practice may be effected through the presentation of science from the perspective of more than a single world view. For students to understand the process of science, its place in society and the culture, and its traditions, it is important for educators to acknowledge that students, themselves, may operate within disparate world views and that it may be difficult for some students to accept any given scientific perspective. Once teachers have made the commitment to critically reflect on their teaching it may be possible for them to identify specific assumptions regarding the nature of curricular practices and possible student and teacher perspectives.

As part of their teaching, educators need to include the implicit and explicit, science-related knowledge that each student brings to the classroom setting. This is one means by which teachers can legitimize the content of their curriculum and build a relationship of trust with students. It can also help in affirming all students if each is given the opportunity to share knowledge and to offer feedback on that of others.

It is recommended that junior high science teachers and educators in positions of leadership advocate and stress the use of concrete materials and models. This study has suggested students express a definite preference for lab-related activities. If junior high science students are operating, for the most part, at a concrete operational level, it would be wise to make much more use of visuals and manipulatives. Many of these may be simple, inexpensive materials that students can choose and provide. By accommodating more student input and permitting them frequent choices, teachers may be going a long way to stemming indifference and making school science an enjoyable learning experience.

It would appear that one focus of future research ought to center on teacher practice in pre-service and in-service settings. Such practice would entail the presentation of science as inquiry within the context of different world views, using the Habermasian model, for example. In their presentations, teachers would practise identifying and making explicit assumptions on which science, as inquiry, is based. They would, also, identify and make explicit those assumptions upon which any world view is based. These presentations would utilize and promote student discussion. The important task for research would be to determine the effects of such teacher practice on the perceptions of science by participating teachers, supervisors, coaches (if any) and students.

In the teaching of science concepts and their historical development, it would be important for teachers in any school science setting to promote the notion of competing views and explanations as part of "normal science." The task of research here would be to determine how such an approach might affect the way in which students view their own conceptions of science.

Another exploratory focus for future research might be the evolution of student perceptions of school science in the formative period early in the school term. These perceptions could be compared and contrasted with perceptions held by students prior to their initial entry into that class. The purpose of this research would be to identify and characterize those teacher actions that are interpreted by students as an affirmation of them as "students" and as "persons."

Personal Reflections

This situational-interpretive study afforded many opportunities to pause and evaluate my experience in light of the initial problem statement and intent of the study. Early evaluation resulted in a shift in the main focus of the research from one emphasizing a rather narrow perspective of meaning to one searching for a broader basis in meaning. This shift has facilitated my "coming to a fuller understanding" of what it means to be a science student and science teacher.

In one important sense, however, the focus was not altered. The communication between teacher and student was increasingly the center of student thought as more student interviews were conducted and as follow up discussion and validation took place. In my own mind, this observation only confirmed the importance students seem to place on having a good working relationship with their teacher.

During my period of observation in Mr. T's classroom, I was agitated and probably frustrated by the infrequent opportunities for students to take an active part in the lesson. Very few students seized those opportunities. Privately, the few students who raised the issue expressed no reluctance to conversing with Mr. T before or after class but did not wish to risk "not knowing" or "being wrong" in front of peers. Critical reflection on this observation suggested to me that there was more "going on" here than simply a student being right or wrong. My sense of the situation was that Mr. T's conception of curriculum did not provide for discussion where students could acquire the language of science and confidently share their understandings in a non-threatening environment.

How, then, could students laud Mr. T on the one hand, and speak of boredom on the other while being essentially passive for so much of their experience in the classroom? It seems students were characterizing their teacher as Mr. T, the "person" and Mr. T, the "teacher." There appears to be no confusion in the minds of students on this issue; hence, no dissent. In fact, very early on I was struck by the positive tone in the classroom.

It became clear as the interviews and follow-ups were conducted that students had been given several lab activities during the school year to which they attached great importance. These activities may have been frequent enough to temper any unrest that might otherwise have developed. In any event, these were seen in a positive light and probably contributed a lot to Mr. T's being perceived as a good teacher or the "best science teacher."

In retrospect, the inclusion of Mr. T as an informant helped validate student perceptions and strengthen the thesis argument that the student-teacher relationship is a dialectical one. I made the decision to interview Mr. T from my own conviction as a science teacher and as a graduate student that a good relationship between student and teacher may be fundamental for optimal learning.

BIBLIOGRAPHY

Aoki, T. T. (1983). A commentary on case studies of science teaching. Edmonton: University of Alberta, Department of Secondary Education.

Apple, M. W. (1982). Education and power. Boston: Routledge & Kegan Paul.

Barnes, D., Britton, J., & Rosen, H. (1969). Language, the learner and the school. Harmondsworth, England: Penguin Books.

Bates, G. C. (1978). The role of the laboratory in secondary school science programs. In M. B. Rowe (Ed.), What research says to the science teacher, Vol. 1. Washington, D. C.: National Science Teachers Association.

Bell, J. B., & Ackerman, P. (1979). The early adolescent and the junior high school curriculum. Edmonton: Department of Secondary Education, University of Alberta.

Benson, G. D. (1984). Teachers' and students' understandings of biology. Unpublished doctoral dissertation, University of Alberta, Edmonton.

Berger, P. L., & Luckmann, T. (1966). The social construction of reality: A treatise in the sociology of knowledge. Garden City, New York: Doubleday & Company.

Bettelheim, B. (1981). Our children are treated like idiots. Psychology Today, 15(7), 28-44.

Bochenski, J. M. (1965). The methods of contemporary thought. Dordrecht, Holland: D. Reidel Publishing Company.

Bowers, C. A. (1984). The promise of theory. New York: Longman Incorporated.

Bowles, S., & Gintis, H. (1976). Schooling in capitalist America. New York: Basic Book, Incorporated, Publishers.

Brophy, J. E. (1982). Successful teaching strategies for the inner-city child. Phi Delta Kappan, 63, 527-529.

Brown, R. H. (1977). A poetic for sociology: Toward a logic of discovery for the human sciences. New York: Cambridge University Press.

Carkhuff, R. R. (1969). Helping and human relations: A primer for lay and professional helpers (Vol. 2: Practice and research). New York: Harper and Row.

Cicourel, A. V. (1972). Cognitive sociology. Harmondsworth, England: Penguin Books Limited.

Coats, W. D., & Swierenga, L. (1972). Students' perceptions of teachers -- a factor analytical study. Journal of Educational Research, 65, 357-360.

Cooke, B. F. H. (1977). Pupils can help teach the teacher. Curriculum Inquiry, 7, 349-353.

Cooper, C. R., & Petrosky, A. (1974). High school students' perceptions of science teachers and science classes. The Science Teacher, 41(2), 22-26.

Cusick, P. (1973). Inside high school. New York: Holt, Rinehart, & Winston.

Dallmayr, F. R., & McCarthy, T. A. (Eds.). (1977). Understanding and social inquiry. Notre Dame, Indiana: University of Notre Dame Press.

Dawson, J. A. (1979). Validity in qualitative inquiry. Urbana-Champaign: University of Illinois.

Dobson, R. L., Dobson, J. E., & Koetting, J. R. (1982). The language of teaching-effectiveness and teacher-competency research. Viewpoints in Teaching and Learning, 58(2), 23-33.

Eastridge, H. E. (1976). Student evaluations and teacher performance. National Association of Secondary School Principals Bulletin, 60(6), 48-54.

Edwards, A. D., & Furlong, V. J. (1978). The language of teaching: meaning in classroom interaction. London: Heinemann.

Everhart, R. B. (1983). Reading, writing and resistance: adolescence and labor in a junior high school. Boston: Routledge & Kegan Paul.

Feyerabend, P. K. (1975). Against method. London: NLB Humanities Press.

Fullan, M. (1982). The meaning of educational change. Toronto: OISE.

Gallagher, J. J. (1984). A study of policy and program formulation and implementation in a secondary school science department. In C. W. Anderson (Ed.), Observing science classrooms: Observing science perspectives from research and practice, 1984 AETS yearbook. Columbus: ERIC Clearinghouse for Science, Mathematics, and Environmental Education.

Gazda, G. M. (1973). Human relations development: A manual for educators. Boston: Allyn and Bacon, Incorporated.

Ginsburg, H., & Opper, S. (1979). Piaget's theory of intellectual development. Englewood Cliffs, New Jersey: Prentice-Hall, Incorporated.

Giroux, H. (1985). Intellectual labor and pedagogical work: Rethinking the role of teacher as intellectual. Phenomenology and pedagogy, 3(1), 20-32.

Goodenough, W. H. (1981). Culture, language, and society. Menlo Park, California: The Benjamin/Cummings Publishing Company, Incorporated.

Goodlad, J. I. (1984). A place called school: prospects for the future. New York: McGraw-Hill Book Company.

Greene, M. (1973). Teacher as stranger: Educational philosophy for the modern age. Belmont, California: Wadsworth Publishing Company, Incorporated.

Guba, E. G. (1980). Criteria for assessing the trustworthiness of naturalistic inquiries. ERIC/ECTJ Annual Review Paper, Indiana University.

Hall, E. T. (1977). Beyond culture. Garden City, New York: Anchor Press/Doubleday & Company.

Harms, N. C. (1981). Project synthesis: summary and implications for teachers. In N. C. Harms, & R. E. Yager (Eds.), What research says to the science teacher (Vol. 3). Washington, D. C.: National Science Teachers Association.

Hasan, O. E. (1975). An investigation into factors affecting science interest of secondary school students. Journal of Research in Science Teaching, 12, 255-261.

Hofwolt, C. A. (1985). Instructional strategies in the science classroom. In D. Holdzkom, & P. B. Lutz (Eds.), Research within reach: Science education. Charleston, West Virginia: Appalachia Educational Laboratory.

Holt, J. C. (1983). How children learn. New York: Dell Publishing Company, Incorporated.

Huebner, D. (1975). Curricular language and classroom meanings. In W. Pinar (Ed.), Curriculum theorizing: The reconceptualists. Berkeley: McCutchan Publishing Corporation.

Hurd, P. D. (1983). Science education: The search for a new vision. Educational Leadership, 41(4), 20-22.

Jones, R. S. (1982). Physics as metaphor. Minneapolis: University of Minnesota Press.

Kargbo, D. B., Hobbs, E. H., & Erickson, G. L. (1980). Children's beliefs about inherited characteristics. Journal of Biological Education, 14, 137-146.

Koballa, T. R. (1985). Goals of science education. In D. Holdzkom, & P. B. Lutz (Eds.), Research within reach: Science education. Charleston, West Virginia: Appalachia Educational Laboratory.

Koehn, J. J. (1984). The silent curriculum: More than intuition. In P. L. Hosford (Ed.), Using what we know about teaching. Alexandria, Virginia: ASCD.

Kohl, H. (1967). Thirty-six children. New York: The New American Library.

Kyle, W. C. (1985). Curriculum development projects of the 1960s. In D. Holdzkom, & P. B. Lutz (Eds.), Research within reach: Science education. Charleston, West Virginia: Appalachia Educational Laboratory.

Lawrenz, F. (1976). Student perceptions of the classroom learning environment in biology, chemistry and physics courses. Journal of Research in Science Teaching, 13, 315-323.

Lortie, D. C. (1975). Schoolteacher: A sociological study. Chicago: The University of Chicago Press.

Macdonald, J. B., & Leeper, R. R. (Eds.). (1966). Language and meaning. Washington, D. C.: Association for Supervision and Curriculum Development.

Matthews, G. B. (1980). Philosophy and the young child. Cambridge, Massachusetts: Harvard University Press.

McMillan, J. H., & May, M. J. (1979). A study of factors influencing attitudes toward science of junior high school students. Journal of Research in Science Teaching, 16, 217-222.

Mehan, H. (1979). Learning lessons: Social organization in the classroom. Cambridge, Massachusetts: Harvard University Press.

Meighan, R. (1981). A sociology of educating. Toronto: Holt, Rinehart and Winston.

Merleau-Ponty, M. (1962). Phenomenology of perception. Translated by C. Smith. New York: Humanities Press.

Michalko, R. (1984). The metaphor of adolescence. Phenomenology and Pedagogy, 1, 296-311.

Moore, E., & Kocan, E. (1983, March-April). How students see the public school system. The B.C. Teacher, 172-173.

Morgan, G. (1983). Beyond method. Beverly Hills: Sage Publications.

Okey, J. R., & Butts, D. P. (1982). Linking teacher behaviors and student behaviors in science. In M. B. Rowe (Ed.), Education in the 80's: Science. Washington, D. C.: National Education Association.

Oldham, V. A. (1982). Interpretations of difficulty in high school biology. Unpublished master's thesis, University of Alberta, Edmonton.

Polanyi, M. (1964). Personal knowledge. New York: Harper and Row.

Reason, P. W., & Rowan, J. (Eds.). (1981). Human inquiry: A sourcebook of new paradigm research. Toronto: John Wiley & Sons Limited.

Risi, M. (1982). Macroscole: A holistic approach to science teaching. Ottawa: The Science Council of Canada.

Rogers, V. R. (1984). Qualitative research -- another way of knowing. In P. L. Hosford (Ed.), Using what we know about teaching. Alexandria, Virginia: ASCD.

Rossman, M. (1983). The cheese: An essay on method in science teaching. Phi Delta Kappan, 64, 632-634.

Rowe, M. B. (1977). Teachers who care. The Science Teacher, 44(5), 37-38.

Rowe, M. B. (Ed.). (1982). Education in the 1980's: Science. Washington, D. C.: National Education Association.

Rowe, M. B. (1983). Science education: A framework for decision-makers. Daedalus, 112(2), 123-142.

Science Council of Canada. (1983). Case studies of science teaching (Vol. 3). In J. Olson, & T. L. Russell (Eds.), Science education in Canadian schools. Ottawa: Authors.

Schutz, A. (1962). Collected papers I: The problem of social reality. Edited by M. Natanson. The Hague: Martinus Nijhoff.

Schutz, A. (1971). Collected papers II. Edited by A. Broderson. The Hague: Martinus Nijhoff.

Shotter, J. (1978). The cultural context of communication studies: Theoretical and methodological issues. In A. Lock (Ed.), Action, gesture, and symbol: The emergence of language. New York: Academic Press.

Shulman, L. S., & Tamir, P. (1973). Research on teaching in the natural sciences. In R. M. Travers (Ed.), Second Handbook of Research on Teaching. Chicago: Rand McNally and Company.

Shymansky, J. A. (1978). How teaching strategies affect students: Implications for teaching science. In M. B. Rowe (Ed.), What research says to the science teacher (Vol. 1). Washington, D. C.: National Science Teachers Association.

Simpson, R. D. (1978). Relating student feelings to achievement in science. In M. B. Rowe (Ed.), What research says to the science teacher (Vol. 1). Washington, D. C.: National Science Teachers Association.

Spindler, G. D. (1963). Education in American Culture. New York: Harper and Row.

Spindler, G. D. (Ed.). (1974). Education and cultural process: toward an anthropology of education. Toronto: Holt, Rinehart and Winston, Incorporated.

Squires, D. A., Huitt, W. G., & Segars, J. K. (1981). Improving classrooms and schools: What's important. Educational Leadership, 39, 174-179.

Stake, R. E., & Easley, J. A. (1978). Case studies in science education. Urbana: University of Illinois.

Stauer, J. R. (Ed.). (1982). 1982 AETS yearbook: Review on science education. Columbus: ERIC Clearinghouse for Science, Mathematics, and Environmental Education.

Stephens, M. (1982). A question of generalizability. *Theory and Research in Social Education*, *9*(4), 75-89.

Stevens, J. T. (1981). Learners as a source of educational objectives for the middle school. In D. V. Ochs (Ed.), *Improving practices in middle school science*, 1981 AETS yearbook. Columbus: ERIC Clearinghouse for Science, Mathematics, and Environmental Education.

Tannas, C. (1983). *Implications of humanism for the Alberta six-year French program*. Unpublished colloquium, Department of Secondary Education, University of Alberta.

Taylor, C. (1977). Interpretation and the sciences of man. In F. R. Dallmayr, & T. A. McCarthy (Eds.), *Understanding and social inquiry*. Notre Dame, Indiana: University of Notre Dame Press.

Turbayne, C. M. (1970). *The myth of metaphor*. Columbia, South Carolina: University of South Carolina Press.

Welch, W. W. (1981). Inquiry in school science. In N. C. Harms, & R. E. Yager (Eds.), *What research says to the science teacher* (Vol. 3). Washington, D. C.: National Science Teachers Association.

Welch, W. W. (1985). A science-based approach to science learning. In D. Holdzkom, & P. B. Lutz (Eds.), *Research within reach: science education*. Charleston, West Virginia: Appalachia Educational Laboratory.

Werner, W., & Aoki, T. T. (1981). *Programs for people: Introducing program development, implementation and evaluation*. Edmonton: Department of Secondary Education, University of Alberta.

Werner, W., & Rothe, P. (1979). *Doing school ethnography*. Monograph Series No.2. Edmonton: University of Alberta, Department of Secondary Education and University of British Columbia, Center for the Study of Curriculum and Instruction.

Wilson, S. (1977). The use of ethnographic techniques in educational research. Review of Educational Research, 47, 245-265.

Yager, R. E. (1983). The importance of terminology in teaching K-12 science. Journal of Research in Science Teaching, 20, 577-588.

Yager, R. E., & Penick, J. E. (1984). What students say about science teaching and science teachers. Science Education, 68, 143-152.

Yamamoto, K., Thomas, E. C., & Karns, E. A. (1969). School-related attitudes in middle-school age students. American Educational Research Journal, 6, 191-206.

APPENDIX A

WORKING INTERVIEW GUIDE FOR STUDENTS

Working interview guide for students

1. Try to imagine your teacher is speaking these words as I read to you a part of yesterday's lesson.

2. What did your teacher mean when he said "________________________________"?

3. What's the first thing that comes into your mind when you are asked to "________________________"?

4. What does "________________________" mean to you?

5. What's it like being asked to "_________________"? Putting it another way, being asked to "_____________________" is like . . .

6. Describe all you can about your teacher when he said this.

7. Did the way your teacher asked you to "____________________" help you understand what he meant? How?

8. How did you feel when he said this?

9. What's it like being a science student?

APPENDIX B

EXCERPT FROM REFERENCED LESSON - TEACHER INTERVIEW

Excerpt from referenced lesson for teacher interview

If you do that, if you . . . I don't say you're going to have 250 pages to summarize in each course. If you summarize and shorten things up and then . . . keep writing things down I think you'll take it in a lot better than looking at it. For some reason it seems to bounce off those gray cells if you're just reading it. It seems to have to go through, and some of it stays there if you're writing, or, even doing it orally. You're quizzing each other orally. How that material goes through the brain, I'm not sure. I don't know the mechanics of that; I'm not sure that anybody does. But it seems to go through and penetrate and stay there. Even if you're asking each other questions, as long as you've had to think and come up with an answer, the brain has got your mouth in gear . . . hopefully, and the answer, if it's coming out correctly, you'll remember it.

Now, today I'd like you to finish up the experiment you started the other day. The film is supposed to be in this week. It was supposed to come in today . . .

APPENDIX B

EXCERPT FROM REFERENCED LESSON - STUDENT INTERVIEW

Excerpt from referenced lesson for a student interview

Before I scare you to death on this, I'd like to warn you that what I'm going to be showing you in forms of chemical equations I do not expect you to be able to do at the end of this period or even the next or the next but within about two weeks you should be able to do similar things to what I'm gonna go over in this class. I will write most of the chemical equations on the board. I prefer teaching with the overhead projector, but it just doesn't have a wide enough screen to write everything on and keep it in a row. We're dealing with chemical equation[s]. In a way, it's like a mathematical equation and a math equation is easier, I think, to solve if you can keep it all written across the page rather than have some of it here and some of it down lower. To me, it's easier if you can keep it organized straight across the page to solve it.

APPENDIX C

WORKING INTERVIEW GUIDE FOR TEACHER

Working interview guide for teacher

1. Try to imagine yourself speaking these words as I read with you a part of an earlier lesson.
2. What did you mean when you said "________________"?
3. What's the first thing that comes to mind when you hear "____________________"?
4. What does it mean to you to say that?
5. What do you think it meant to your students?
6. What's it like to say "________________________"?
7. Describe yourself: voice, face, hands, body movements and position, while saying "________________________"?
8. Did you do anything with your body or appear any particular way that helped convey the intended meaning?
9. What's it feel like when saying that?
10. What's it like being a science teacher?

APPENDIX D

PARENT CONSENT FORM

Parent Consent Form

April 20, 1983

Dear Parent:

I ask your cooperation in having your son/daughter participate in a research study. Please read the following statement and sign below. Return this form with your son/daughter as soon as possible.

I give my son/daughter, ____________________, permission to participate in a research study in which he/she may be asked to comment about selected teacher instruction. All comments will remain anonymous.

____
(Parent/Guardian Signature)

Thank you.

Sincerely,

APPENDIX E

STUDENT INTERVIEW TRANSCRIPTIONS

I What do you think your teacher meant when he said, "*I* think"?

B Well, that in his opinion or from teaching other classes, his own experience, he knows that it's better to write it all the way across the page . . .

C He sorta like states his opinions for what he thinks we're gonna think . . . more or less what *B*________ said.

B He could have said "in my opinion" or "I *suggest*".

I Let me ask you what it means to *you*.

B Okay. It means to me that he [was saying] . . . It's his opinion that he thinks . . .

I What does it suggest? Does it suggest a *doing*, a behaving? a way for something?

B Yah, it suggests a way of doing whatever it happens to be.

C You're thinking about how *you're* gonna do it; how *you're* gonna figure it out.

B Well, in a way you compare your way of doing it to teacher A's way of doing it and see if they . . . if they're anyway the same; whether they're exactly the opposite like whether you would do it that way or whether you think it's a . . . it's just a good way of doing -- a smart way or reasonable, or do you think it doesn't make sense and your way would be better than that.

I What's the first thing that comes into your mind when he says, "I think"?

C He's not too sure about it. It's his opinion on how he thinks math equations are.

B In a way he could be saying that it's *his* method of doing it or it's *a* method of doing it but you don't have to follow that method. But . . . it's helped him when he's done those questions, those types of questions, mathematical questions . . .

I What's it *like* to be asked that? Told that? For someone to say that as a teacher? What's it like to be the *student* hearing that?

C Sometimes you really don't know what he says when he says, "I think" 'cause you might have different meanings of what he's saying when he says, "I think".

B You could interpret it, say . . . the wrong way. But I don't know. If you're talking about different teachers and they say, "I think", then it might be hard for you to understand what teacher A [meant] . . . He usually conveys the message across and we get the same meaning as what he's saying, so . . .

I Do you recall what he was doing? Any kind of movement looking at his face? Can you see him doing this? This part here . . .

B Yah. It isn't as though he's making it as a joke or he's not saying it seriously. You can tell in his face that he means it as part of the *lesson* and not just as a joke in between, or you know, just to break the mood or somethin' like that. And from just the way he . . . his movement that he's really trying to show us that it would be better . . . all the way across on the page instead of . . . you know, breaking it up.

I Okay, what movements are we speaking of here?

C (hands) He's expressing that . . . longer. He might be comparing instead of going halfway [across] the page, just go [all the way across]. (face) The same as usual. After he explains something [he's] looking all over the room, the whole students, not just at one person.

I Do you recall him looking at you when he was saying this?

C Oh yes.

B He looks at everybody.

C He kept, more or less, a straight face when he was talking.

I Was he moving around?

C He was standing and walking, maybe just a couple of steps. Just sort of against the blackboard to . . . around his desk . . .

B Yah.

C . . . and back again or near a chair.

B Just kneeled on it or something like that, not further from his desk to the blackboard.

C Yah.

I What can you say about his voice?

B It definitely has authority in it, but not authority where he's always mad at everybody or anything like that. Everybody knows his place, that he *is* the teacher and that . . . I mean not that he's going to whip you or anything if you get out of place, but they know that they should be quiet and [he] just get[s] a little louder or say[s] this and this person, don't do that.

I What about volume? How loud is he?

B Teacher A usually talks loud but then that's when experiments and stuff are going on, but not as though it's deafening or anything like that, but everybody can hear him. It's not as though you have a problem.

I Now I've been sitting in . . . I sat in on a couple of classes and I would like to know if you pick up anything that you see is different. Is he speaking a little bit louder do you think?

C It's more or less the same routine as he's done before.

B Yah.

I Nothing unusual in his voice?

B No.

I What can you say in regard to my presence?

B No. I don't think it bothers him at all. That's the way he always is. He's just going through his [routine].

I Is there anything he did that helps you understand here?

B The main thing is . . . the movement of the hands and his speech. Just by watching him tell that . . .

C You get the meaning of it.

I What helps give the meaning to words?

B If you would have been laughing or smiling or something . . . you know, if a person does that they automatically or most of the time you don't believe them when they're saying something. But teacher A wasn't doing that. He was just talking as though it was a conversation or just his normal teaching methods. It's not as though . . . I don't think anybody didn't believe him.

C If he says something he usually . . . Okay, let's say he tells us something that he's putting us on. He'll usually tell us a couple a minutes later he was puttin' us on and he gets on [with] the real things; he gets to the point and he explains it well.

I Is there anything you can tell from his voice or his mannerisms that it is an *opinion* that he is giving?

B Well he's not saying: *this is* the right way and this is the way you *have* to do it. He's sayin' . . .

C He's letting you decide what you wanna . . .

B Yah.

C This *could* be used but you don't have to use it.

I I would like to know how you felt when he said this.

B I felt that teacher A knew what he was saying and kind of . . . leave it in his hands to tell you the right way.

I How are you feeling? Describe *your* feelings.

B Trustworthy.

C Kind of excited because it's something new you were taking up. You want to learn just about everything you can. I didn't feel anything.

B You just take teacher A's word for it. That it is most likely the best way to do whatever it happens to be.

I What's it like to *be* a science student?

B Well, I suppose that depends whether you like science or not. In our case, we both like science and if you have the right teacher it makes it a whole lot easier and a lot more fun than if you have really . . . just a . . . not a proper teacher and just makes it a lot better.

C It's more fun when you have a teacher that knows what he's talking about.

B It's always a challenge because you learn something new just about everyday.

C It's fun because you don't keep on going over and over the same thing again. Like . . . some of it's related to each other but most of the time it's just like separate things, like different things not related. Yah [lot's of variety].

B Yah, like *C*________ said. You don't go over the same thing day after day . . . a little before . . . it's always a new thing, experiment or unit, new investigations, whatever the case may be. But it never goes over, over and over again.

I Is that part of the challenge?

B Yah. And then we don't know how the experiments will end up or anything like that so it's always exciting to see its . . . [conclusion].

I What's it like to be a science student after you leave the doors? Do you see yourself still as a science student?

B I don't think I do.

C It depends on what you did that day. Like if it's something that you really liked and you'd like to try it again, you might go home and try doing it yourself.

B There's still a challenge there and, you know, just because you say you're in this exact classroom . . . it doesn't mean that if you went home and tried it, [like] *C*________ said, that there still wouldn't be the challenge there.

I What do you think your teacher meant when he said "I think you can see there's quite a difference."?

E Well, he means you can understand it. He thinks you know how to do it? He thinks you can understand it. I don't know. That you're able to? I think that he thinks we're able to see that . . . that we should be *able* to. We should be able to "see if there's a difference". That's about it.

I Anything else?

E Not really.

I What do *you* mean by that?

E About the same. I think you can see "there's quite a difference". *Yah.* Well, that's what I would've said. About the same.

I What's the first thing that comes into your mind?

E That we should be able to see "that there is a difference" [and] make sure I notice there *is* a difference. You should be able to tell there is a difference. You should be able to . .

I *Better* be able to?

E Not really.

I What's it like to hear that?

E Nothing really. Just . . . I don't know. There's nothing (I don't) think.

I Do you remember watching your teacher?

E Yah, I remember.

I What's *that* like?

E I don't know. He was just looking at the stuff and just seeing there was a difference. We couldn't see it because we're at a bad angle there. He was motioning that there was a difference.

I What's it like to hear him say "I think"?

E I don't know. I don't really notice that he says that. I just listen to him. I didn't notice anything important about it or anything.

I You don't hear him say this.

E Not really. Just . . . no, just part of the sentence.

I Did you hear him say "I think"?

E Maybe not.

I You might hear what's going on (from) the rest of the sentence?

E Yah. Hm hm. If someone's saying something to you, you hear parts of what he's saying. You usually understand [him].

I Describe your teacher for me with reference to the part "I think", and to what is typical.

E When he does an experiment he always . . . I think he always shows what he's doing. He keeps the class like . . . I've never really heard him yell or anything. Nobody really gets out of hand in his class *either*. So it's pretty good. He walks around and sees what you're doing all the time. Well, that's pretty good. He's *always* pretty calm. He seems to know what he's doing. Well, he was just standing around the table (at the front of the room). He's doing the experiment up front. He was talking pretty calmly and looking at what he's doing.

I Did he look around the room?

E Yah. He usually asks if you're finished.

I Was he looking at you?

E Not particularly.

I You were watching him?

E Yah. He usually stands up unless we're working and then he sits down.

I Was he doing anything with his hands?

E Well, not really, just . . .

I Was there anything he did that helped you understand?

E Yah, well like . . . the thing was kinda far in this . . . like mostly that's what he was talking about up there.

I Was he using his hands?

E I think so (but I'm not quite sure). He was showing in the experiment. This is what he was talking about [here].

I Anything in his face?

E Not really. He doesn't really do much . . . the expression on his face.

I Can you visualize him saying this?

E Yah.

I Nothing in his face?

E Not really. Doesn't really, from what I've noticed. (There's nothing) in his face. I wouldn't notice when he's doing anything when he does that, like, it's just natural. Like . . .

I Did he do anything with his voice?

E Not that I remember (during the passage). Well, sometimes . . . he talks a little louder.

I Does he do anything with words so you pay attention to them more or to make words seem more important?

E Not that I really noticed. Some teachers do. I can't think of anything off hand.

I Describe his voice.

E It's kind of deep. He's usually pretty calm.

I What about volume?

E *Some* teachers get *pretty* noisy, yelling and, I don't know. About average. He doesn't talk really loud or anything. Not really (loud).

I How long have you been in his class?

E Two years.

I Was there anything that he did that helped you understand?

E Not really. He just . . . he said it and I remember 'cause I couldn't see it. So he was showing it with hands up there. That's about it. Just lookin' at it and that. He looked around so . . . Not really, I don't think so.

I Describe how you felt. What sorts of feelings did you have when he said that?

E Oh, not much really. We were just lookin' at the question, writing things down and . . . science, not much, like it wasn't exciting or anything. Just an average day. Kinda bored (I guess). It was just regular stuff. I don't know. He was talking to somebody, __________ and I. I was just thinkin' about . . . science marking. I was just thinkin' about the questions we're doin' now, at the same time. I wasn't really . . .

I Was this your typical kind of lesson?

E Yah. I think so.

I What's it like to do an experiment on your own as opposed to a demonstration?

E Well, a lot more activity (on your own) 'cause like they don't have enough, like, equipment for what I was doing yesterday so . . . Yah, we do a lot of experiments and that.

I Would he prefer *you* to do the activity?

E *Yah*, I think so. He usually starts out like demonstrating. Then we go and do it ourselves.

I Are demonstrations helpful?

E Yah. If you don't understand what's happening and at least *then* you'll *know*. It's hard sometimes to understand. They're asking you to do on paper . . . from the books.

I Do you prefer to dive in and do it yourself?

E Not really. Yah (I'm quite happy with the way it is) 'cause usually you have lots of time to work on things yourselves. I think that helps us (carrying out somebody else's instruction and being told exactly what to do). Like . . . he does . . . the instructions are in the book and you just . . . the way things happen so . . .

I You have a good knowledge of what you're expected to do then?

E Yah. . . . to work on.

I Sometimes you have to work it out (for yourself)?

E Yah.

I Did you have any other kinds of feelings?

E Not really.

I What's it like to be a science student in this (situation)?

E *I* think it's pretty good. I do the best in science 'cause I like science most.

I Why?

E I like doing experiments and that, not just like . . . I get to walk around, get stuff and you do different things. It's more activities, not just sittin' around working on the stuff. I think it's better that way. It's pretty good. Like I don't know what it's been like in other schools but I have lots of stuff here so I think it's pretty good.

I Stuff?

E Equipment and that. I'd say it's pretty good. It's usually pretty good.

I Other words for "pretty good"?

E Interesting . . . when you do these chemical things. It's not *always* interesting but some of the books we do (are).

I When you leave the classroom do you still see yourself as a science student?

E Not really. Just in here, I think. After, it's whatever class you're in is usually what you're thinking about. I look forward to science. 'Cause if there's science coming up I don't mind . . . I think about [science] a little bit if you did something interesting. You talk about an assignment.

I Do you get homework on a regular basis in science?

E I wouldn't say so. Usually you can finish the questions in class if yah . . . You get homework once in a while. Not that often.

I He give you lots of time in class?

E Yah. Tests you study for [at home] ; that's about *it*.

I Are you doing well in science?

E Oh, yah. It's my best mark.

APPENDIX F

TEACHER INTERVIEW TRANSCRIPTION

I Okay, first of all, try to imagine yourself speaking these words - all the way through all the questioning here. The first question I'd like to ask is what did you mean when you said, and this refers to the part that is underlined, "as long as you've had to think . . . and come up with an answer". What did you mean when you said that? "As long as you've had to think . . ."

T. I think just as long as they've had to restructure whatever they were taking in, in such a way that they can communicate it back. You can't communicate without thinking. Whereas you can read a piece of . . . you can look at a piece of paper without doing any communicating and then you don't have to be doing any thinking at the same time. So, I think the thinking just means, as far as I was concerned at that time, it simply meant that they have to think enough in order to express what they, what they *want* as an answer. They can't avoid somehow conceptualizing what was going on.

I So in all of what you've said there, the key word would be "restructuring"?

T Perhaps "restructuring". Organizing it in their mind in order to communicate it, whatever it happens to be.

I If I were saying that, if I were the teacher and I was saying that, what would be the first thing that would come into your mind if you heard me saying that? "Even if you're asking questions, as long as you've had to think . . . and come up with an answer". What's the first thing that kinda pops in . . .?

T In the encouragement that, to put me in the place of the student . . . I guess that's kind of awkward, but what I've been trying to encourage all year long is the fact that if they have not attempted to come up with answers on their own during class work, during their own time, then at the time of exams they will have not been practising this particular skill and will be just out to lunch as far as being able to answer on an exam. It's like practising anything, if you don't practise it you probably aren't going to be able to do it. The example I've given them before earlier in the year is that it doesn't matter who the pianist is, Liberace does not go to Carnegie Hall and put on a show at Carnegie Hall without practising before he's gone there. And if they haven't practised trying to conceptualize and come up with answers they aren't going to be able to do it at that point.

I These are the questions that you've asked in class or are these ones that are part of the modules or both?

T Both. I try to encourage them to have something down on paper. At times when I mark it, I mark it mostly for their attempt at doing the answers rather than the correctness of their answers so that at least I know they've had to try to come up with some way of communicating back to me. And quite often when I mark an assignment I mark it on the number of questions that they have taken seriously and tried to answer. Whether the answer is correct or not at that point sometimes is not relevant, when I am marking their assignment. We go over it afterwards so that they *do* have the right answers available. I'm not sure I'm answering *your* question or not.

I I asked you what you meant when you said that. Now I guess I'm asking the same question again but somehow there's some deeper meaning or some depth attached to it. If I say what does it mean to you to say "as long as you've had to think . . .", apart from some kind of literal meaning, is there something else going along with it, some other message going along with it, with those words? Or do you think you've answered that already with your comments?

T Yah. I think that . . . .

I Something implied?

T To me the implication is getting involved becomes a learning process. Being a spectator, learning can't be particularly good spectator sport. It's much more effective as a participant than it is as a spectator, just trying to watch it coming off the page.

I Okay, let me ask you what you think it means to your students for them to hear that?

T To me it's a . . . What I'm hoping they're getting is encouragement to attempt things and feel that they will not be ridiculed for having, maybe thinking something that isn't what I want them to come up with as an answer but trying to think about an answer and not being afraid to come out with one. I particularly stress that kind of thing usually at the beginning of a unit of some sort where we're coming up with something new and try to get new kids involved that perhaps have been kinda sitting back quietly. I like them to feel that I feel more comfortable with them if they're trying to communicate back with me and that I can't really help them very much if they're not. Because if they're not trying to communicate back with me I don't know where I stand with them or where they stand with me. So what I am hoping they are saying is; okay I will attempt to come up with an answer. I don't know whether I can come up with that answer or not but I will try to come up with an answer and I'm not gonna get ridiculed or feel embarrassed if my answer isn't correct. That your request of me is to consider an answer based on what you already know, put it into words and whatever the answer is it will be accepted in some degree or another.

I Do you think that that's the feeling they have though? It's kinda separating what your expectations are, what you hope for and some kind of a realization of where they're at and what they've . . . At some point you ought to be able to say that there's this ideal. This is a goal and in some real sense this is what I think they probably mean by what I'm saying. You've expressed your intentions but maybe there are cues. Maybe there are . . . The feedback you're getting says they're "right here" which maybe is where you want them to be but, on the other hand, it may not be. So, from the kind of feedback you're getting, the messages you're getting, taking it all together, what would the . . .

T Okay. I think if they don't come up with the kind of feeling that I expect they're getting and this happens quite often, I don't know whether it happened in this particular instance or not, if they don't come up with the feeling that I think they're getting and it's happened to me many times, it's up to me to reteach the lesson in such a way that they *are* getting *my* message. Many times, well I shouldn't say many times, I'm getting a little better at reading students I *think*. But I know in my first few years teaching every once in a while I would stop and say, hey I thought I've done this correctly and now what I'm getting back and what the understanding of the students is, is not what I thought I was teaching them. So, therefore, I would have to stop and go back and teach them again. I don't feel that way as often now as I used to. So, yes, I think they're getting the message. I'm not sure I'm articulating what they're supposed to be getting as clearly as you'd like me to or even as clearly as *I'd* like me to.

I But if you were to use that term, let's suppose you were to use the term "I would like you to think about this and come up with an answer", do you feel that they would be expected to know what they're to do at this point in time?

T If they were given a specific task to think about and come up with an answer, I would expect that *most* of them, I certainly never expect that all of them are going to interpret what I want them to think about but I want them to organize their thoughts *somehow* and be able to come up with an answer as opposed to coming up with some kind of a wild guess. That's all. There's a difference between making a wild guess at it and stopping and considering it, at least a little bit of time trying to put it into a clear answer of some sort.

I You put the sign up after the start of the year or before the start or . . .

T The sign?

I Yes. Did that come out at the beginning of the year or did it come after?

T It was at the beginning of the year.

I Right at the very beginning?

T Right at the very . . .

I Before the appeared or after?

T Yes, before the appeared. I've . . .

I That's [a response] from previous experience?

T That was remade this year.

I Ah.

T Or last year.

I Mm Hmm

T And it's been up in my room for probably six or seven years. It wears with age and I redo it to make it look a little neater, that's all.

I When you say "don't even think about" that, what are you asking them not to do? Very briefly.

T Oh, I think I'm just exaggerating the term that they are not to in my room. It's just a method of exaggeration I think at that point. That's all that it's meant to be.

I 'Cause I could read that as something like, if I were translating it literally, probably *consider* would be a fair word to put in. *consider*. Is that the intention or do you have some other kind of . . .

T Yes, consider would be a good . . . hm hm.

I Let's go back to the excerpt here again and let me ask you what it's like to say that? You may want to take a little more of the context into consideration here. What's it like to be a teacher and to be saying that?

T Are you referring to the underlined section or are you referring to the paragraph?

I Yes [I'm referring to the underlined section] but you can take a little more into account there. In the sense when you have an English exercise . . . your teacher . . . says, playing baseball is like, or falling out of an aircraft is like . . . in a simile . . . sense. How would you answer? Relating this to your students is like . . . What sort of things come to mind if anything?

T I guess it's kind of like passing on a . . . what I'm trying to do there is sort of pass on a recipe for at least some academic success just as you'd . . . to people that I am concerned about. Just as I would pass on a recipe for some kind of a meal to close friends if I thought that they would enjoy that particular meal or benefit from it. To me in a way I guess it's my recipe that worked for me, whereas, when I didn't follow that particular recipe things did not go that well for me. They did for a while until finally I had to have some other method of going about doing things and that seemed to work out quite well. So, I guess I'm hoping that they will benefit and I know that I never do but I guess I'm dreaming, hoping [that] they will benefit by somebody else's mistake rather than having to find it out themselves. I probably expect that they're going, to find out the same . . . a lot of them are going to do the same mistakes and have to find out for themselves rather than listening to my particular recipe. So I guess that's what I was thinking as a recipe for being able to . . . retain . . .

I Let me give you an example just to maybe conjure up some other notions that might be there that you haven't thought of. Maybe giving instructions or a comment like this . . . for some teachers it might be a kind of power trip. Okay?

T Hm hm.

I Do you see the kind of things behind the action? Now with that example . . . only as an example, does that suggest anything else as to how you might see yourself?

T It certainly doesn't suggest anything to a power trip to me.

I No. That's only an example.

T Oh, I see.

I That's sorta something that's behind . . . what it's like to do what you're doing. I mean you . . .

T I don't find my *occupation* to be a power trip *either*.

I No, no.

T Am I reading, or not?

I No. I don't want to deal with the power trip notion. That was just an example of . . . like it sorta takes it *outside* of the immediate context of what you're saying to what's sort of behind your feeling of what it's like. It's almost making this (reference to the excerpt) irrelevant, the fact that you're doing and you're up there. This might be an image you have of yourself (reference to power trip). I'm not saying it very well. Giving an instruction is like a power trip I guess is the example and . . .

T Okay, it . . .

I I mean . . . you answered one way. Is there anything else that comes to mind now with that example, other ways you might see, what you said here, it's like?

T No.. I can't really interpret that any other way I don't think. Not at the time anyway. Maybe so I have a little more time and I have time to think about it but I'm not reading anything else into it . . . into that at all.

I Okay, fine. How would you like to describe yourself as you see yourself here doing this. Maybe say something about your voice, your face, your movements, whole body.

T While I'm doing that or . . .

I Ya. I think the whole . . .

T While I'm generally teaching?

I No. Try to maybe, if you can, recall that day . . . or anything about, you know, enough of the lesson to pinpoint specifics, but as well as you can, as close as you can: voice, hands and your general body movements and position. Things that kids can . . .

T I'm not sure how any of it relates directly to the kids. I just know that I do try to put emphasis on by . . . by hand motions, by . . .

I What kind of movements are these?

T Oh, when I talk about putting it through the gray cells I'll point to my head . . .

I Yes.

T . . . to sort of emphasize what I'm talking about as far as gray cells go.

I How do you keep your hands? I mean do you do this sort of thing with your hands? (hands moved in circles)

T I do various things. I don't remember what I was doing exactly *that* time. Sometimes I sit on my stool frontwards and I have my hands just hanging, just sitting in my lap, or I'm talking with them, or other times I hang on to the . . . I sit on the stool backwards so that the back of the stool is out front. That particular day I really could not remember which way I was.

I Right.

T I know that my hands do not stay on that stool.

I Ya.

T They move around. Whether to . . . I think it's just part of my teaching technique in that if you're animated to a certain extent you are attracting the attention of the students you're trying to communicate with and if you're sitting there completely still you're *not*. I don't even remember at that time if I was walking around the room. I know that at times that I do. I'll walk around the room and talk, sometimes just to be animated myself and sometimes to discourage too much animation amongst the students at that particular time.

I Are you conscious of hand movements when you make them?

T Semi-conscious of hand movements. I don't stop and think about it in any . . .

I How 'bout your voice? How would you describe your voice?

T Hm. Again I try to use my voice to produce energy as part of animation.

I Do you equate that with volume or is that something . . .?

T Not necessarily. Sometimes perhaps with the speed of the words. Hesitation, not necessarily always talking smoothly.

I A break in the flow.

T A break in the flow. Quite often that break in the flow is when I'm talking with my hands but it . . . At all times I try to be energetic in my speech and hopefully my voice varies enough to not become monotonous.

I Okay, varies in the speed. How about the pitch?

T Well, that's what I mean when it varies. Hopefully it varies enough in the pitch as well but whether it does or not . . .

I How would you describe the voice, the normal pitch or tone. It's not the same thing but . . .

T Okay. I don't listen to myself very often. I've listened to myself on tape a few times. I find that on tape I don't think I sound like I sound normally, of course. Not just the pitch and everything but I don't feel the energy on tape that I feel I'm producing otherwise. And, so, maybe what the kids are getting is not what I'm feeling I'm getting. But, at the same time, the tapes that I've done have been pretty serious lecture type of materials that were intended for a kid to sit for ten minutes and pick up some materials in a unipack approach.

I Right.

T It was pretty serious stuff. It was the kind of stuff . . . I guess my voice animates with my hands and you can't animate with your hands on tape.

I Not easily.

T Not too easily. Not on audiotape anyway.

I Certainly not without a lot of deliberate conscious effort.

T Yah. But what it is to listen to it, I don't know.

I Would you describe it as deep, for example?

T It's relatively . . . I think it's relatively deep.

I How about volume? How do you rate your volume? I guess it's pretty difficult to remember for this passage?

T Ya. I use volume for effect. I'm not sure that I did it during this passage. But I use . . . I certainly try to communicate with anybody who would be up to ten feet behind the back wall so that I know I'm not just talking to some one or two students in the front row when I'm doing that.

I Relative to other staff how would you rate in terms of volume? Towards the high end?

T I think I'd be relatively towards the high end in terms of volume. Yes.

I I guess having asked you for a general description, would you like to summarize anything that you felt you did or anyway you appeared, can be either behavior or appearance, that would tend to enhance the meaning particularly of the part that's underlined. But maybe the part that's around it too. Is there any conscious . . . If you were doing that now . . .

T Yah.

I . . . it would be worth considering that too.

T Okay. One of the things that I was doing during this and I usually do it when I am making some kind of a lecture is to take *little* things here and there and try to communicate them, I suppose I am communicating, trying to communicate with the whole class at any one time. But through eye contact and so on I try to communicate with some students saying: hey, you know I think maybe you can benefit from what I'm having to say. So there's that and even the eye contact coming back tells me quite often whether they are not only paying attention but whether any of it makes sense to them and quite often, I didn't notice it here particularly, quite often I'll be saying something I think everybody gets but then I'll take a look at one student, or two students or something, and there's a very puzzled look on their face which says to me: okay, I'm not hearing what . . . at least I'm not hearing something I can understand. What are you talking about? In here, in this particular thing on study techniques or review techniques, I didn't recall any of that particularly but I'm sure it was going on. I don't know if that's the kind of thing you're looking for.

I I sense from your comment in another class where you were . . . maybe it was the same one, I'm not sure. It was early on, maybe the 9-1's. It was in reference to . . . yes, it was the 9-1 class who had come out on top on a test and you made reference to not looking at two or three students who were . . . had been dragging the class down . . .

T Sure. At the same time you know they are looking at you.

I With the notion that . . . and that tells me that you *do* look at students. . .

T Yes.

I That you're conscious of your looking at students.

T Ya. I look at students. I try to look at students and communicate with them while they're communicating with me *without* the rest of the class necessarily being aware that I'm talking to them. That doesn't necessarily only apply to the bad students but even to the good students because sometimes the peer pressure on the good students is: eh, you know, he's always getting the best mark. Why do you keep saying all these good things about him? Even though you don't mention that; or her, you don't mention that particular person's name. So sometimes when I talk about *them* I just refuse to make eye contact with them at that time either, but they'll know whom I'm talking about. In 9-1 it's particularly noticeable with one student in over the last few months who has been having some trouble in my class and she's come up to me afterwards and she said, "you were talking about me in class today, weren't you?" I said, "ya, I was." and I'd ask her if she thought the other students knew that I was talking about her and she said, "no." Maybe some of her really close friends did [know] who knew her marks but generally the people in the class weren't sure whom I was talking about.

I What you're suggesting is an awful lot being communicated, for example through eye contact, that doesn't appear in words.

T I think it, not only through . . . ya, through eye contact and many other . . . many forms of eye contact. Ya know there's positive eye contact and there's negative eye contact. I think I use both eye contact and facial expression. You know if I sit there and look like I'm bored out of my tree they certainly are going to be too and there are some cases in grade eight science where I say: hey, look, this is not the most interesting stuff that you're going to be taking in your science or in your school career. We got to go through it; let's put up with it and do what we can, get it covered and go on to something that everybody, you and I, are going to enjoy more. And I think I relate through my physical appearance that I'm enjoying what I'm doing *most* of the time. Certainly, I can't say that I enjoy what I'm doing *all* the time. I don't think anybody in anybody's job can. Maybe they can but I'd like to meet them.

I I've noticed two things you were doing frequently. One was raising your eyebrows just as you were a moment ago and also winking, winking at students.

T Yes.

I And are you conscious . . . obviously you're conscious of winking, I would . . . I can't see how anybody wouldn't be conscious of that but . . .

T Right.

I What about the eyebrows. Is that something that you're . . .

T Ya.

I Is that part of the energy? Do you feel that?

T Yes. Yes, it's part of facial animation.

I Ya.

T Ya know . . . my animation (slight laugh). . . Okay. I sit on the stool a lot but I still feel animated. My first few years teaching I used to wander a lot and the kids for the first few years there, for the first year or two, they come into my class for the first couple of weeks they were having trouble following me 'cause one of the things I was criticized for as a student teacher was for teaching behind the desk all the time.

I Ya.

T And all of a sudden I said: I don't, I really don't. It wasn't because of that criticism necessarily, but I thought it was just part of my animation. I didn't feel animated student teaching. I started subbing and then I began feeling that I could motivate kids by showing that I was motivated to do the job.

I I can identify with a fair bit of that in my experience. It's been very positive . . . good feedback with that kind of . . .

T Hm hm.

I I mean there's contact in moving close to a student, eye contact. What's it feel like? I'll ask you about your feelings when you're doing this. I guess we touched on that a little bit before when I asked what's it like but considering the whole range of feelings and all possibilities that there could be . . .

T Okay. I think quite often the rewards in teaching are the fact that you're making a visual, positive communication with the student or some other kind of positive communication and having them respond positively. Not all of them do it but I think that a lot of the reward in teaching is that you feel good. But, okay, you've mentioned winking at a student. Okay. you wink at a student and they smile. They say: you know, you like me; I like you back; you're okay. I don't have to say that. And, I'm not here . . . I'm not in teaching for a popularity contest either. I can get by. I get by fine. I know that some students and I are going to get along well and I hope most students and I are going to get along well. And there are students I'll never get along with. If I . . . I suppose when I first started I couldn't see why I couldn't get along with everybody but I learned that pretty fast that that doesn't work. It doesn't matter whether you're teachers or students or friends and neighbours or relatives or whatever. But I feel good in the communication I get back from *most* of the kids. An excellent example a while back. I took a strip off one of the kids in 8-6. Just tore up one side of her and down the other and just ten minutes later she walked out and had left me a Christmas card on my desk, [the] only one in the class that left me a Christmas card on the desk (laugh). I talked to her afterwards and said: you know you made me feel as low as a worm's belly when you got finished. I said: but the same time I certainly felt good about it. I feel . . . I really like junior high students. I don't think I like grade seven's. They drive me crazy, their enthusiasm and their "watcha doin' now" sort of thing bothers me. But, generally, I like junior high students. I feel quite comfortable with them. So, I think that's how it makes me feel to sit up in front of a class and say: hey, I think I can help you guys.

I It's very much a very strong . . . relationship. That seems to be in a nutshell, how you feel. If you're relating . . . it's a relating kind of feeling.

T Ya.

I It's not an isolating . . .

T No. No . . . no, I've seen teachers on staff here who I have felt if you can't relate you shouldn't be teaching and they're complaining all the time. Now when *I* complain, I'll complain about an individual student and most of the time it's done in a joking fashion anyway. There's very *few* and there's a few . . . and I've complained about a couple this year but very few really . . . kids that get excluded by substitutes. I know when I leave my classroom which kids are gonna get excluded by substitutes because they . . . it's both people's fault. The substitute can't interpret the kid, interpret the way the kid is saying things and I tend to interpret it just a little bit differently, I suppose.

I One . . . quickly, what's it like being a science teacher?

T As opposed to being another kind of a teacher? I don't think it makes any difference. I think whatever kind of subject matter that I've got myself in . . .

I Maybe as opposed to being anything else.

T Having not tried anything [else] I . . . Okay. I like the chance to be communicating with kids. The only other kind of thing that I would be interested in really would be something along the lines of music or drama in which case I'd also be communicating with kids.

I Very much so. Well you *are* in drama.

T I maintain that the teaching business is an entertainment business. If you can't entertain them enough to get their interests over and above all the other interests that they have in and out of school then you can't motivate them whatsoever. And whether the motivation be through a personality or through subject matter or whatever it happens to be, it's gotta be there somehow.

APPENDIX G

ONE STUDENT'S PHENOMENOLOGICAL DESCRIPTION

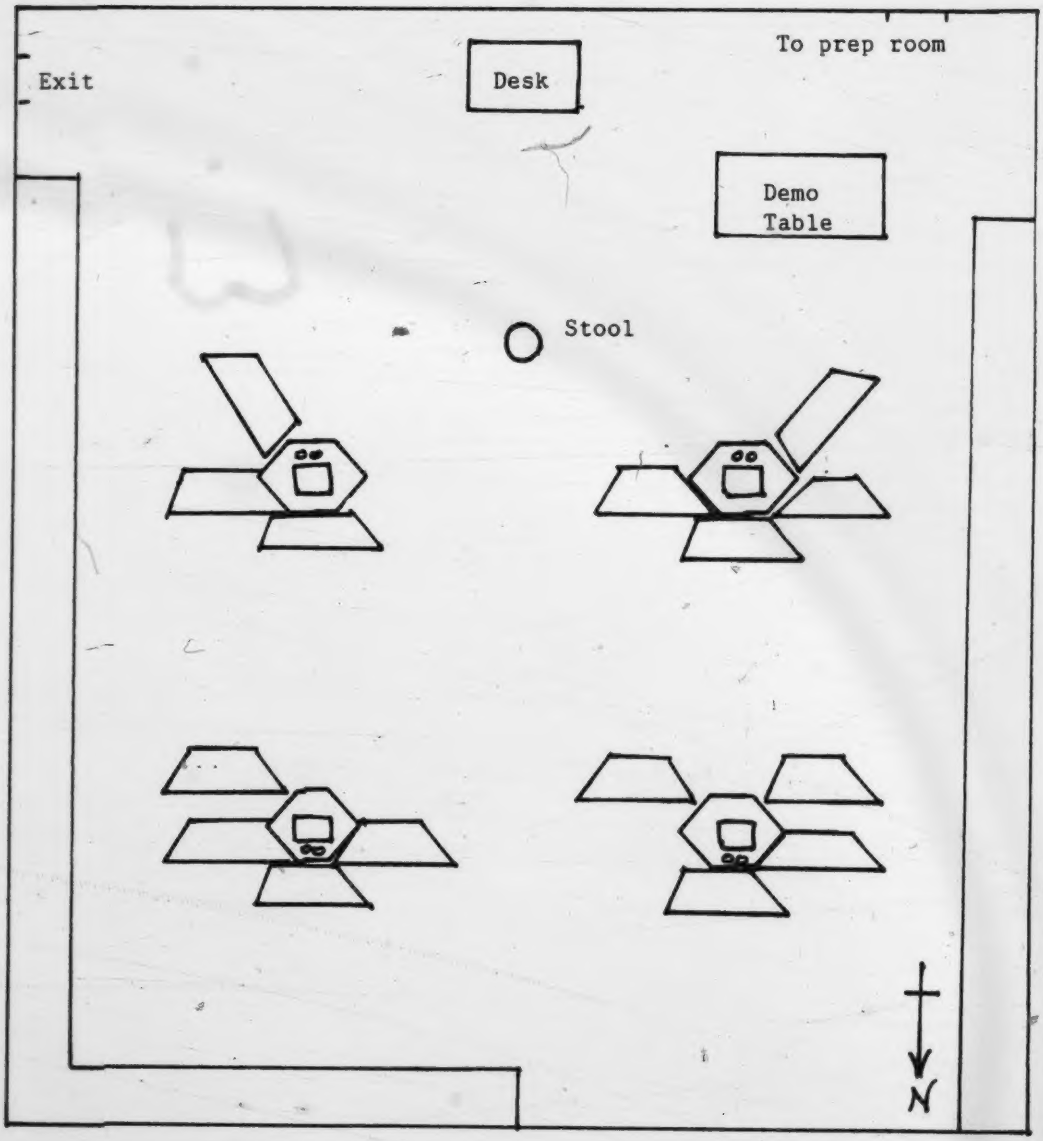
One student's phenomenological description

Science was very interesting last year. It was very exciting to learn new things. Science was never boring. There was always something new to learn and try. Science last year was very helpful in furthering my studies, as many of my science courses are based on this. I always felt my body go rigid with excitement when it was said that we would be starting a new experiment or a new unit. This was of great enjoyment because I enjoy learning new things about things around me and also things far away from me. To learn something I find useful is a great experience. I always looked forward to science. I always wished the period would last longer; it was always too short. Time seemed to fly too fast. I felt a sense of accomplishment knowing I now knew something I didn't know before. I didn't think it was fair that I had to do the experiments basically by myself because M________ and L__________ wouldn't help very much. My tests would always be good in my science class. You could let the experimental side of you come forward. It was a great reward to have an experiment work for you. I was sorry when the grade nine science year came to an end. It could have gone on forever.

APPENDIX H

A PLAN VIEW OF MR. T'S CLASSROOM

A plan view of Mr. T's classroom


Exit
Desk
To prep room
Demo Table
Stool
N

APPENDIX I

SAMPLE OF GRADE NINE UNIT INVESTIGATIONS

Investigation 1

Chemical reactions may be recognized by one or more pieces of evidence.

Problem: How do you know when a chemical change takes place?

Background Information:

Matter can be changed in many different ways. All changes are either physical, chemical or nuclear. A physical change involves a change in size, shape or form, but does not involve a change in composition. Changes resulting from melting, boiling, crushing, tearing or grinding are all examples of physical change.

A chemical change results in a different composition of the materials involved. The atoms and molecules of the original substance are rearranged to produce a new substance. When a piece of wood is burned, all that is left is a small pile of ashes. The wood did not only change physically (in size, shape and form), but also there was a change in the composition of the materials in the wood. The original substances were changed to other substances.

It is not always easy to tell whether a change has been physical or chemical. The best way is to observe whether the substance that has changed can be changed back to its original form by physical means. Usually only physical changes can be reversed in this way.

How do we know when a chemical change has taken place. Usually heat or light are given off or a gas is produced. However, in cases where two clear liquids are involved, a precipitate may be formed. A precipitate is a solid material which may result from the mixing of two clear liquids. It usually remains separate from the liquid and does not dissolve in it.

Chemical changes go on all around us constantly, but they often go unnoticed. The reactions within an automobile engine, the cooking of food, and the life processes within your body are all complicated chemical changes that you seldom notice. The kind of chemical changes that you see and remember are those in which a building burns down or a firecracker explodes. One reason you remember such changes is that they are dramatic and happen rapidly. The chemical change that occurs in paper as it discolors with age is so slow that you might have to wait for months or years to observe any change at all. In this information set we will attempt to set forth types of evidence of chemical reactions.

Design:

Materials:

test tubes, 13 x 100 ml
50 ml graduated cylinder
iron filings
bunsen burner
test tube holder
barium chloride ($BaCl_2$)
cobalt chloride ($CoCl$)
potassium iodide (KI)
dilute hydrochloric acid (HCl)
copper sulfate solution ($CuSO_4$)
marble chips ($CaCO_3$)
calcium (Ca)
sodium sulfate ($Na_2(SO_4)$)
silver nitrate ($AgNO_3$)
lead nitrate ($Pb(NO_3)_2$)

Part A

1. Add iron filings to a clean test tube to a height of about 0.5 cm.
2. Pour about 4 ml of copper sulfate ($CuSO_4$) solution into the same test tube.
3. Using a test tube holder, hold the tube over a bunsen burner flame. Heat gently for two minutes.
4. Allow the test tube to cool. After making your observations, discard the contents.

Part B

5. Dissolve about 0.2g of barium chloride ($BaCl_2$) crystals in about 10 ml of water.
6. Dissolve about 0.2g of sodium sulfate crystals in another 10 ml of water. ($Na_2(SO_4)$)
7. Mix the two solutions. Observe.
8. Prepare and mix solutions of the following pairs of substances and add the results to your observation table.
   - (a) cobalt chloride ($CoCl$) and silver nitrate ($AgNO_3$)
   - (b) potassium iodide (KI) and lead nitrate ($Pb(NO_3)_2$)

Part C

9. Add 4 ml of dilute hydrochloric acid to a clear test tube.
10. Carefully add a small marble chip to the acid.
11. Record your observations.
12. Repeat the above procedure by adding a small piece of calcium to water.

Observations:

Procedure		Description of material before using	Description of material after using	Has a chemical change occurred?	Reason for your answer in previous box
A					
B	1				
	2				
	3				
C	1				
	2				

Inferences

Part A

1. What type of evidence do you have that a chemical reation has taken place?

2. What products do you see evident during the reaction?

3. Write the chemical symbol for each of the products.

Part B

4. What evidence do you have that a chemical reaction has taken place in each pair of chemicals?

5. What is an identification test for lead nitrate?

6. In what states are the products that are formed?

7. How could you separate these products?

Part C

8. What evidence do you have that a chemical reaction has taken place in each case?

9. Calcium carbonate ($CaCO_3$) reacts with hydrochloric acid (HCl). What product do you see evidence of during the reaction?

10. How could you separate the products of this reaction?

11. Calcium (Ca) reacts with water (H_2O). What is the product that you see evidence of in the reaction?

12. How could you identify the products of these reactions?

13. Summarize the three different types of chemical reactions that took place in this investigation.

Further Evidence:

If you mix hydrochloric acid (acid) and sodium hydroxide (base), a chemical reaction takes place.

It is not of the type studied in parts A, B, or C but there must be some evidence of the reaction taking place. What would you notice as evidence of this chemical reation?

Investigation 2

Problem: To study simple decomposition and simple combination chemical reactions.

Background Information:

Energy changes always occur during chemical reactions. These energy changes may be in the form of heat and light, as when wood burns. Or they may produce electricity as in the storage battery of an automobile. Many chemical reactions require heat, light, or electricity in order for them to take place. Chemical changes usually involve the forms of energy called heat, light, or electricity. In this investigation, we are going to study a simple decomposition and simple combination reaction.

Part A - Simple Decomposition Reaction

Decomposition reactions are those in which a compound is decomposed by heat, light, or electricity, into simple compounds, or elements. The decomposition type reaction is characterized by the general formula:

$$AB \longrightarrow A + B$$

AB is the original compound. A and B are elements or simple compounds into which the original compound decomposes.

Decomposition reactions can be divided into two types:

a) those that give off energy when they are taking place (exothermic reactions). Although this type of reaction is quite rare, there are a few examples:

Hydrogen iodide gas (HI) will decompose to form hydrogen gas (H_2) and solid iodine (I)

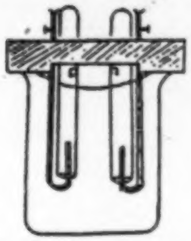
Carbon disulfide (CS_2) will decompose into carbon (C) and sulfur (S)

b) those that require energy for decomposition to occur (endothermic reactions). The electrolysis of water is such a reaction. In the investigation that follows, we are going to determine the component parts of water (if any), and the relationship that they (the components) bear to each other.

Design: **Materials:** Brownlee apparatus, which includes a battery jar, two small test tubes, platinum electrodes, a battery, and connecting wire
10% diluted sulfuric acid
2 - 18 x 150 mm test tubes and stoppers
water
wooden splints
matches
stirring rod

NOTE: Your instructor will discuss the safety precautions to be followed when working with acids.
Safety glasses must be worn during this investigation.

1. The Brownlee apparatus for the electrolysis of water is shown at the left. Use the following steps to ensure that your apparatus is set up properly.



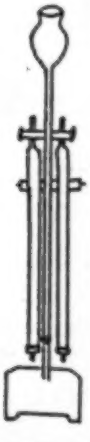
Brownlee apparatus

a) Attach the apparatus to the side of the battery jar.

b) Add water to the battery jar until it is about 1 cm above the top of the electrodes.

The Hoffman apparatus, shown below, may be used as an alternative.

2. You are going to collect the products of this decomposition by a procedure called "downward displacement of water."



Hoffman apparatus

c) completely fill a test tube with water.

d) Place a small square of cardboard tightly against the mouth of the test tube.

e) Carefully, turn the test tube upside down, while holding the cardboard in place. If there is no air in the test tube, you should now be able to remove your finger from the cardboard and it will stay in place. (If there is air in the test tube, and you did not do this over a sink, by now you are probably all wet!)

f) Immediately lower the test tube into the water in the battery jar and carefully shake off the cardboard. KEEP THE MOUTH OF THE TEST TUBE BELOW THE SURFACE.

g) Carefully clip the test tubes over the electrodes.

3. Connect the battery and observe any changes in the appearance of the test tubes of electrodes.

4. After 2 minutes, add 10 ml of dilute sulfuric acid to the water in the battery jar and stir with a stirring rod (Not your finger!)

5. How does the addition of the sulfuric acid affect the reaction?

____

____

____

____

6. What appears to be the ratio of the two gases collected?

____

At which terminal does each collect?

____

7. When one test tube is filled with gas, disconnect the battery, light a wood splint, quickly remove the test tube and immediately insert the lit splint into the mouth of the test tube.
Examine the inside of the test tube. Record your observations.

8. Replace the test tube with a fresh water-filled test tube and continue the procedure until the other (now half-full) test tube is full of a gas.

9. Now light a wood splint, blow it out and while it is still glowing, remove the second test tube and immediately insert the splint into the second test tube. Note any effect. Record all observations.

Observations:

7.

9.

Inferences:

1. What is the chemical formula for water? ______________________

2. Using the formula for water and your experimental observations, identify the gas collected in each of the test tubes.

3. What is the test for the presence of each of the gases indicated in Question 2? Explain.

4. What is the ratio of the two gases collected?

5. Upon examining the terminals at which each of the gases collected:
   a) what gas collected at each of the terminals?
   b) what charge must each of the gases undergo in order to collect at the terminal they did?

New Problems:

1. Suggest a chemical equation for the decomposition of water. (Use a reference text if necessary.)

   Write both the word and symbolic formula equation for the decomposition of water.

   Equation:

2. Why was sulfuric acid added to the water in the battery jar?

3. Define the term "catalyst".

   catalyst

   Name the catalyst(s) in this investigation. (Refer to a reference text if necessary.)

   What was the effect of the catalyst on this reaction?

4. What is an "ion"?

5. Were there any ions in the water in this experiment? Explain.

6. What is a "molecule"?

____

____

7. The gases produced from the electrolysis of water are said to exist in molecular form. Why is this so? (Do research to find the answer if necessary.)

____

____

____

____

8. List the molecules encountered in this investigation.

____

____

____

9. Why is the electrolysis of water classified as a decomposition reaction?

____

____

10. Would the electrolysis of water work without electricity? Explain.

____

____

____

Further Evidence:

1. Your teacher will provide you with 6 test tubes of hydrogen gas and 6 test tubes of oxygen gas. Carry out the 6 standard gas tests on each group. The gas tests are described below. Begin by doing these tests on 6 test tubes of air.

Test Tube 1. Observe color, odor and taste. (N.B. Use proper methods to observe odor and taste.

Test Tube 2. Open test tube in an upright position and after 15-20 seconds insert a burning splint. Observe (If the gas is lighter than air what will be in the tube after 20 seconds?) ______________________________
If the gas is heavier? ______________________________

Test Tube 3. Repeat as in test tube 2 but hold the test tube upside down. Observe (If the gas is heavier than air what will be in the test tube after 20 seconds?) __________
If the gas is lighter? ______________________________

Test Tube 4. Open the test tube in upright position and after 15-20 seconds insert a glowing splint. Observe (If the gas is lighter than air what will be in the tube?) __________
If the gas is heavier? ______________________________

Test Tube 5. Repeat as in test tube 4 but hold the test tube upside down. Observe. (If the gas is heavier than air what will be in the test tube after 20 seconds?) ______________________. If the gas is lighter? ____________________________.

Test Tube 6. Open and add 1 cm of limewater. Re-stopper and shake the tube. Observe.

Results

Test Tube	Air	Hydrogen	Oxygen
1.			
2.			
3.			
4.			
5.			
6.			

In which test tubes do the results for hydrogen appear similar to results for air?

____

Why? ____

Descriptions	Air	Hydrogen	Oxygen
Color			
Odor			
Taste			
Does it burn?			
Does it support combustion?			
Density compared to air	SAME		
Does it contain CO_2?			

2. There are six general types of decomposition reactions. Do research in order to identify the six types of reactions.

a) ____________________

b) ____________________

c) ____________________

d) ____________________

e) ____________________

f) ____________________

3. Write the word equations and/or symbolic equations for the following decomposition reactions.

a) nickel chloride $\longrightarrow$
$NiCl_2$

b) hydrochloric acid $\longrightarrow$
HCl

c) barium chloride $\longrightarrow$
$BaCl$

d) mercury II iodide $\longrightarrow$
$HgII_2I_2$

e) potassium bromide $\longrightarrow$
KBr

f) hydrogen peroxide $\longrightarrow$
H_2O_2

g) potassium chlorate $\longrightarrow$
$KClO_3$

Part B - Simple Combination Reactions

Combination Reactions are those in which one substance reacts with another substance to form a compound. A general equation for this type of reaction is:

$$A + B \longrightarrow AB$$

In this general equation A stands for one substance and B for another substance. AB is the compound formed. In our case the substances we will be combining are actually elements.

Most combination reactions produce energy. They are exothermic reactions.

NOTE: Safety glasses are to be worn during this investigation.

Design: **Materials:** test tube of hydrogen gas (prepared in Design Part A)
wooden splint
matches

Method:

1. Light a wood splint. Then remove the stopper from your test tube and immediately insert the lit splint into the mouth of the test tube. Record your observations.
2. Examine the inside of the test tube. What has collected on the inside of the test tube? Record all observations.

Observations:

1.

2.

Inferences:

1. As was discussed in the Background Information, most combination reactions produce energy. Was any energy produced in this experiment? Explain.

____

____

____

2. What compound was produced when the hydrogen burned?

____

3. What component part of air combined with the hydrogen?

____

4. Write both the word equation and the symbolic equation for the chemical combination reaction in this investigation.

5. In this investigation energy was given off in two forms. What were the two forms of energy produced?

   a) ______________________________

   b) ______________________________

6. It is obvious that the product of a combination reaction must be a compound composed of the two reacting elements? Did this hold true for this investigation? Explain.

____

____

____

____

____

New Problems:

Complete the word equation and/or symbolic equation for the following combination reactions.

a) sodium + chlorine ⟶

b) magnesium + oxygen ⟶

c) iron + oxygen ⟶

d) hydrogen + chlorine ⟶

e) carbon + oxygen ⟶

APPENDIX J

STUDENT INTERVIEW DATA

Twelve student descriptions are presented below. These students represent a wide range of academic abilities and scholastic achievement. Final grades in science range from 50% to 85% for the present school year. The students also show variance in demonstrating social skills: some students being very quiet; others very much outgoing. Two of the students speak a first language other than English.

Each student description begins with a brief sketch, essentially a self-portrait. The remainder of each description is interview data that have been organized under issues the students, themselves, raised during interviews. Thus, topics are not necessarily ones identified by other students.

Arlene

Arlene is a 15 year old grade eight student. She is achieving at 71% in her science. She is sometimes a serious student; not too happy. At other times she is happy; glad. Arlene says she is polite, never rude to the teacher. She is very cooperative with other students and with the teacher in doing what he asks. English is not her first spoken language.

Boring

Science is boring. Part of the reason is the teacher when he just talks all period. It's his expressions - the way he's saying it. I can't understand those funny, scientific, words. They're long and don't tell you the meaning. I'm bored when there's nothing to do. For example, you're given an assignment and you don't really know what that assignment is about. So, if it's boring, you don't know what you have to do. You're not really into it and you feel like you're missing out on something - misplaced. You're not concerned; that is, I don't care about it - science labs, books or assignments. We're not going to use it for our future, later on.

Understanding

When I understand something I feel happy. It comes easy to you. I get, or know, what he's talking about. The scientific words make the subject hard to understand.

Liking Science

I like science when we're watching a film or doing an experiment or talking about a new unit or somethin' like doing diagrams. Science is my favorite subject [at that time]. He lets us be on our own. I don't like it when it's hard to understand as when there's scientific words. I like science about an average [amount] I guess. I kinda like it. Well, I like it better than some subjects. When you like it you feel happy; you feel more confident in it. I'll concentrate on it and understand and really pay attention. It's interesting in a way. You understand. When we do something I like, I know I'm going to be good at it. Otherwise, I'm generally looking at my books while the teacher is speaking or I'm watching him.

Attending Class

If I have homework to hand in and it isn't done I don't want to go to science class. I feel scared. You might get into trouble with the teacher. Sometimes he checks homework but you never know when. He'll ask you why you haven't got it done. I've never been caught this year.

Having Confidence

I can believe him if he 'means it'. That is, he's pretty serious about it - not smiling. He gives you more confidence. If you act like a teacher when you study, taking a book in your hand and talking out loud to yourself, you can understand what you're reading and better remember what you're saying. If I know I have homework to hand in [and it isn't done], I don't want to go to science class. Sometimes homework is checked. You get in trouble from the teacher and he asks you why you haven't got it done. I feel scared.

Barbara

Barbara is a 14 year old, grade nine science student. She is strong academically achieving 80% in science in grade eight and 81% this year. She is interested in science and finds it exciting. She feels very confident in her own capabilities and in the classroom setting. For example, she doesn't mind asking questions in class or of the teacher after school. She is a very serious learner.

Liking Science

I like science 'cause we're constantly learning new things. The teacher is never boring and we always do interesting things, experiments and stuff. Units are taught well because I understand everything: I get it "right off the bat". It's like a puzzle fitting together. It's always a challenge not knowing how the experiments will end up or anything like that.

Boring

My teacher never lingers on one subject or gets drawn away from the main topic. Boring means that something is tiresome. It's repeated or it's something that doesn't apply to you. You can tell right away if it's boring or not.

Having Fun

Having the right teacher, a proper teacher, makes things a lot better, easier and more fun. You enjoy doing it. It's something you like to do or want to do.

Trusting the Teacher

I trust my teacher because it sounds like he knows what he's talking about and he's not confused. He explains everything clearly. It's all in one unit; he doesn't break it up and stutter. He doesn't have to go [and] look in his manual or book. I trust him just because of the way he says things. He says something in a confident voice, not shakey. Further, he doesn't put you down if you don't understand something. You know he's there to help you and not make a fool of you. He doesn't degrade you, treat you as though you were in kindergarten.

Gaining Meaning

I think the meaning I get is the same as the teacher's. He tries to adapt himself so he can talk to you properly. He uses a different vocabulary and tries to make it as simple as possible. In a way, you compare your way of doing it to the teacher's way of doing it and see if they're in any way the same. You think if it's just a good way of doing, a smart or reasonable way or you think it doesn't make sense and your way would be better. If it makes sense you understand it and it comes easily; you have no problem. You know if you get the same meaning, if you come out with the same answer or the same solution. You get his meaning by his attitude when he says it. You can just accept what he says 'cause he's the teacher. You hope that he knows what he's talking about. You have to get to know each teacher individually and adjust yourself to each. You consciously change your way of thinking for each teacher.

Knowing Your Place

I know I'm the student and I'm the one that's there to learn. Everybody knows his/her place, that he is the teacher. Not that he's going to whip you or anything if you get out of place but they know that they should be quiet. He just gets a little louder or says "   , don't do that".

Cheryl

Cheryl is 14 years of age and female. She considers herself an average student achieving 60% this year and about 60% last year in grade eight science. She likes science when she does experiments. She doesn't believe herself to be a serious student, not always doing homework. She slacks off at times and doesn't put everything into studying for tests. At times Cheryl is interested and excited; at other times bored. She often doesn't feel too confident, instead rather "kinda uneasy".

Liking Science

I like science. You learn new things every day. It's exciting, different from other classes. I get to experiment, not just sit. You get to try things for yourself. Seeing yourself as a science student after you leave class depends on what you did that day. Like if it's something you really liked and you'd like to try it again, you might go home and try doing it yourself. I did that two or three times. I felt like I was smart and could do it on my own; I didn't need any teacher.

Having Fun

When science is fun there is no repetition; the teacher does not go over the same stuff. You learn faster. You'll get into more and you understand what he's talking about faster. It's change. It's different, something new. It could also be interesting. My teacher tells jokes which make it fun. It's fun when you have a teacher who knows what he's talking about.

Boring

When things are boring (content) you don't really learn anything more. It doesn't have meaning; it goes in one ear and out the other. You might say "Who cares! I'd rather be outside playing baseball." Boring is pretty much the opposite of fun.

Being Interested

When something's interesting it keeps you enthused in what you're doing. It's not an everyday thing. It's a new experience.

Wanting to Learn

I want to learn just about everything I can so you can impress other people such as your friends, or, so you can show off. You want to show that you understand something. Also, you want to impress yourself so you know that you can do it - you know what you're talking about.

Asking Questions

I won't ask questions in class. I'll only ask my teacher if I'm really confused and then only after class.

Being Excited

I'm excited when I know what's going on. Being excited is trying out different things, new experiences. It's learning to do things in more than one way.

Challenging

Being challenged is close to being excited. New experiences are challenging. You're learning more things and adding new words to your vocabulary.

Frustrating

When things are not fun, boring or challenging they can be frustrating. If you don't understand something and he goes over it and you still don't understand, it gets frustrating.

Taking His Word for It

Since he's had a way more experience than I've had and I'm new at it, I'll trust him. He's the teacher. I trust him 'cause he's older. He's taken more courses and knows more about a certain topic. I generally take the teacher's word for it whenever he expresses his point of view on something. That's most likely the best way to go. He knows about different aspects of life.

Getting His Meaning

You get the meaning of what he says by his actions and speech. On "real [serious] things" he gets to the point and explains it well. It might be the way he says it or his facial expressions or his own charisma. Just the way he presents it all to you; his personality. He has an exciting voice. If it's the same dull, boring tone, then you'd lose interest. You start doodling on your paper or think of something else to do. It's the presentation, a step by step breaking up into sections so it's easier to understand. He'll explain it thoroughly, every way you can look at the question. You also get his meaning through his actions. He uses his arms, for example, to estimate the length of something; to give you an idea of how big something is compared to another thing. By the way he moves his hands you can visualize the structure in your mind.

Understanding

My teacher looks at everybody. He looks at you to see if you're understanding, if it's getting to you and not going over your head. He senses my lack of understanding through my facial expressions. My face is screwed up if I don't understand.

Doug

Doug is a 14 year old male student in grade nine. He seems to enjoy science although at times he finds it boring. He likes taking notes and doing experiments but hates multiple choice tests. He sees himself as an average student achieving 55% this year in science, about 10% less than for grade eight science. Doug's native tongue is other than English. English presents a few problems for him. Last year, for example, he took a class in English as a second language.

Feeling the Need to Pay Attention

The way he (teacher) talks he wants to attract your attention using a high pitched voice. If he thinks a test will include some experiments that we did in class his voice will change.

Being a Little Bit Concerned

I am concerned by the way he looks at me. He'll look at students that have the most problems with experiments. I know that he is making reference to me when he looks at me. Without his asking me [a question], his facial expression changes.

Enjoying It

He makes jokes in class about a person, though not especially me. He'll pick any person as the [focus for jokes, sketches, etc.]. Experiments are enjoyable. It's enjoyable doing them with friends. I enjoy the way he lets us handle experiments in class. He doesn't often come around and instruct us. You can go faster. I like doing them. I pay attention when there are experiments.

Boring

It's enjoyable doing experiments with friends instead of with the teacher because the teacher is usually boring. They (teachers) want everything perfect. You're stuck with them. During the experiment with the teacher, there's no chance to talk about outside activities which you can do with friends. I feel like going to sleep. You are watching the teacher do experiments and handle equipment. You don't have a chance to do it. You have a feeling you can do the experiment by yourself instead of the teacher instructing, doing it for you.

Liking the Way He Teaches

He is a good teacher. He helps any student anytime. He insists they have first made the attempt, however. For example: homework. I don't have any free time after school and I can come in in the morning and he'll be there. He explains things very well and the way he sits without moving his hands and pointing [to me]. It bugs me, is distracting, when someone points at me.

Edward

Edward is a 14 year old, grade nine male student. Science is his best subject. He gets his highest mark in science which is his favorite class. Edward is a serious student who enjoys being active in class, particularly his involvement with experiments. His achievement in science this year, 78%, is somewhat better than for grade eight.

Thinking It's Pretty Good

Science is interesting. It's different from regular (other) classes where you just sit all day. It's characterized by action where we do experiments and write reports on them. I enjoy doing it, filling test tubes, watching to see what you've done to find out things that happen.

Liking It

Science comes easiest for me 'cause I'm interested and usually understand what's going on. Therefore, I pay attention and like it. We get to do stuff: experiments, charts; action work that takes more than a day. I do the best in science 'cause I like science most.

Hearing Only Parts of What He's Saying

Sometimes I don't hear everything he says but, because he's actively doing and demonstrating, I'm able to follow the lesson and understand him. Sometimes I lose track when I'm reading in the book (unit booklet).

Thinking It's Better This Way

Instead of just reading what happens you watch what happens. You find out a little clearer. You understand better; that is, you have a better view of things. You know what's happened. You see all of it. You should understand what will happen next - be able to tell after the experiment is completed.

Interesting But Not Always

It's interesting when we do these chemical things. It's not always this way but some of the books (units) we do are. If you've been working on something too long in a certain section and if you don't understand, you sorta dislike it.

Fred

Fred is a grade nine, male student, 15 years of age. Science is seen as a fun class so he enjoys going there. He's 'sorta interested', not bored like in some classes. He considers himself to be attentive, waiting to learn new and interesting things. He likes doing different and exciting experiments. He enjoys being with friends. Fred is a strong student, achieving 90% this year and 70% to 75% in grade eight science. He enjoys asking questions in class and after school.

Enjoying Science

I enjoy science 'cause it's being with friends and it's fun. It's interesting, not boring like in some classes. There is a feeling of wonder as with experiments. They're neat 'cause reactions turn color and they're spectacular. Things burst into flame; I like this sort of stuff. It's kinda neat that you can do something like that. You can put two innocent things together and then it makes some kind of reaction that's pretty spectacular. Friends help make science more fun 'cause you're doing things you like to do with people you like doing them with. You sorta like to be there.

Feeling Good About It

I feel good about science class, partly because the whole class does. There are no "goof-offs", people who would hinder other people who want to learn. I feel good that I am learning something, picking up a lot of information. He's a pretty good teacher.

Being Interested

The class interests me in the kind of topics so I want to learn more. I am interested in some things particularly experiments and stuff. The experiments are all new stuff so you don't get bored because you've taken it before. They're fun 'cause they involve more mental work rather than paper work. We do things that are fantastic, awesome.

Thinking

You don't think all the time in class, so he tells you to think for certain questions. After a question he would say "think about this". This would be sorta your key. He expects me to think first, not guess, and come up with answers. My teacher uses different tones and hand motions to get our attention and to help us understand.

Boring

While you are interested in some things, when you get lectures and tests you're bored. When he's talking it could be interesting but not all the time. Boring could be considered the opposite of interesting but there is a middle ground as well where something is neither. When you just have to sit and absorb [material] as in a lecture then it's boring. Boring things are those that I'm not interested in such as tests and lectures, or, those that I've already done in other courses which have lost their interest. You've already heard all about it; all the wonder has gone.

Greg

Greg is a soft spoken 13 year old, grade eight science student. Science is one of his best core subjects. He achieved about 60% in grade seven and 62% in grade eight science. While science is interesting and is liked, Greg is not that serious in his studies. Schoolwork is not that important to him. Yet, he comes to learn. English is Greg's second language.

Being Interested

I do like science. I learn things that I like more there than I do in other classes. I like science because of the experiments, I guess. They're different from ordinary schoolwork where you do a lot of reading and writing. I want to learn more about science 'cause it could probably help you in the future. I'm interested in different things, like when we took weather. When I'd watch the news I wouldn't know what HIGHS and LOWS were, but now I understand it. Science is not as boring as L.A. where I have to do a lot of writing. I'm interested when something makes sense.

Not Being Important

Something that isn't important is not useful. I might not have to use it; I might not need that information. Maybe I don't need to learn it; I don't need to know it for the course. I don't have to study and memorize it.

Doing Homework

Sometimes homework seems like work; that is, when it's confusing and you really don't want to do it but you have to. It's confusing when you don't understand. Homework is usually either fun to do and easy or it's hard to do and confusing.

Knowing

You know something when you remember it - as soon as it comes to mind. You know it when you've heard it before.

Liking Science

I like science. I think I am learning a lot. I like doing what few experiments we do. The units we learn are very interesting most of the time. The people at my table are easy to work with and I receive a lot of help from him. My teacher makes it easier to get through the units. I respect him for his intelligence and size. There isn't much I don't like about this year's science. I like the films we've seen and the erosion unit. The year has gone by pretty fast; I kinda wish it hadn't.

Jerry

Jerry is a 14 year old male student in grade nine. He has achieved at the 60% level in science for the past two years. Most of the time Jerry is a serious student; that is, he doesn't usually fool around in class. He likes science, finding it an interesting subject. He likes his teacher. Jerry is a little shy; he doesn't ask too many questions in the large group setting. Rather, he asks his friends instead. When his friends do well, it serves as an incentive for him to also do well.

Liking Science

Science is an interesting subject. You learn about stuff you didn't know before. You do experiments; they're kinda fun. It's neat doing experiments 'cause you wonder what's going to happen next. It's often a surprise. For example, earlier this year the teacher inserted a burning splint into hydrogen gas and produced a loud pop (minor explosion).

Being Curious

You're sorta curious when he's talking about interesting things, something special or something he feels you need to know. You're wondering what he's gonna say next.

Paying Attention

When my teacher's talking I'm usually watching him and the expressions on his face. You feel like you're paying more attention when you do this. So when you're looking around the room at posters and other students, you don't feel as though you're paying attention. When the teacher says something in a different tone of voice or when he wants to make something clear by repeating it, I sense that what he's saying is important.

Thinking

He wants us to reason things out; look at all the different things and come to a conclusion of our own so as to know what we're talking about and whether or not it's right. By saying 'so?', 'so what?', 'who cares?' and 'tell me more about it', he wants us to specify more our answers to his questions. It serves as a check on our knowledge.

Liking the Teacher

I like the teacher a lot. He's nice, not crabby, easy going but not too much so. He defines clearly, limits for acceptable behavior.

Kathy

Kathy is a 14 year old grade nine female student. This is her first year at this school. She isn't strong academically in science achieving 32% in grade nine. She doesn't look forward to science class mainly because of the content. Yet, while in class she is always willing to learn something new. She considers herself to be a serious student, not goofing-off and always paying attention. When her teacher gives instructions she tries to carry them out.

Being Interested

Science is interesting at times; at other times boring. It's interesting, doing some of the experiments we do, the way the group sets it up and the way we do it. It's something I've never seen before. It's interesting to find out what's gonna happen next. Interesting is sometimes just something new.

Boring

When I don't understand, it's boring. Once we had to do a unit by ourselves with no help from the teacher. That was hard. Most of the time when it's hard it's boring. I had missed some work from previous years but couldn't arrange to get help from the teacher. This made it hard.

Being Excited

It's exciting to learn new things sometimes. It's a learning experience. Exciting means it's fun, interesting. It's exciting when we do experiments, like we did one time when we had to fill test tubes with water. That was fun, something I've never done before. Techniques such as using balances are useful and kinda fun.

Being Encouraged

I'm encouraged by the way he talks. The tone in his voice and the kind of expression on his face gives me encouragement.

Liking Science

I either like it nor don't like it. It's okay; mostly all new.

Being Confused

At times I am confused in class. Sometimes I don't understand what he's talking about. I guess this is one of the reasons 'I'm really doing bad'. When I am confused I feel that I'm not part of the class or something. I ask for help and nobody helps me. When I have difficulties I'm scared someone is going to find out. So I find it difficult to go after help; 'I just never do'.

Laura

Laura is 13 years old in grade eight. She is "not a very good student", achieving about 55% last year in science and 48% this year. By her own admission she doesn't "put [much] effort into it" and "could do better". She is not that serious a student being somewhat disruptive, particularly in afternoon class and last period in the day when "it gets tiring". She has not, however, been so talkative as to warrant her being sent to the Conference room. She is perhaps conscious of peers as she doesn't want to be favored - not liking to be a teacher's pet.

Boring

When I am tired or when it gets boring I want to be excluded. I don't want to listen to what he's saying. Sometimes it seems the class is really long like the last period in the day. If it's the afternoon it (science) gets tiring.

Listening to the Teacher

If you listen to him you'd look interested and he'd ask you questions. If you look like you don't want to listen then he doesn't really bother you. Sometimes I don't want to listen. When he goes over something that's lengthy or repeats some things, he stalls. Then it just doesn't seem interesting. He raises his voice when he walks around. Loudness is somehow equated to his conviction about what he says - he means it! He is facially expressive. He looks into people's faces. I ask questions when I don't understand. He knows I don't and kinda winks at me and smiles. He'll stop and explain [something I don't understand]. I feel good sometimes, glad, when he tells us we don't have to do something 'cause sometimes it'll not seem interesting.

Liking Science

I like science experiments and different things to do. Yet, I don't like science that much, especially if I have to write tests. I don't put much effort into science; it's not my best subject. If I have a test I don't want to go to science 'cause I do bad on tests. When we do experiments he lets us go on our own, in groups. You feel like you're your own special scientist. He doesn't baby sit you. He tells us what we're going to be doing and then let's us be on our own.

Doing Science at Home

I just forget about everything when I leave class and think about what I'm gonna do at home. However, when I do my science homework, I feel he's right there talking to me. When I'm reading over something I kinda hear his voice, the way he talks and emphasizes things. Picturing him talking helps a little bit. I think about it more clearly. I try to do this [deliberately].

Martin

Martin is a 14 year old male in grade nine who has achieved about 70% in science for the past two years. While he considers himself a pretty good listener, he finds that he's slow to pick things up in science. He likes science and tries to pay attention to what is happening in class. At times his attention is diverted to his friend beside him who asks Martin questions on the lesson at hand. Sometimes something he's been thinking about a lot, of late, pops up and causes him not to watch the teacher or to listen to him. Occasionally, Martin will talk to his friend about outside activities.

Liking Science

I like science 'cause the teacher's nice and it's fun. The teacher isn't strict; he doesn't get mad when little things go wrong. He gives you a second chance. He explains things very well. He doesn't put you on the spot by asking you questions you can't answer. That wouldn't be fun.

Receiving Advice

Occasionally, my teacher will tell us about some of the things that he did wrong which I, as a student, might do wrong. He tries to help us by relating his experience. You might go through what he did so he wants you to know what to expect. If he looks at me when he relates his experience, I feel that he thinks I might be one of the candidates for this kind of advice. Even if he doesn't look at me when he is giving advice, I can still feel this way if it relates to something I didn't understand in an earlier lesson. I'm not uneasy about it.

Listening to What the Teacher Is Saying

When I am watching my teacher I am usually listening to him. When I look away from him I tend not to listen. I think about something else. When my teacher is giving advice I get a mildly positive feeling; I get a good feeling from listening to what he's saying. Sometimes I don't concentrate on what he's saying. As I was listening to this excerpt (under discussion) I wasn't concentrating on what he was saying. I was waiting for science to get started. I was thinking about math: I can't do it (math) all; thinking about getting it done.

Believing the Teacher

My teacher makes himself believable and convincing. He says what he thinks and what he believes. He's outspoken; he explains things as he talks. My teacher talks to us both from behind his desk and from in front. When he speaks to us from in front it's more important. Some teachers sit behind their desks all the time and when they get mad at you or they want to express something more than usual they'll stand up. Sometimes the reverse is true. However, this is not characteristic of my teacher.

Thinking

One thinks so that it doesn't go in one ear and out the other. There is a sense of 'working on' or improving upon what was 'taken in' when one thinks. There is a sense of trying to find an answer. The purpose of thinking is to be able to put things down if you're writing a test. It's a question of getting things out, getting the right words out.

Nancy

Nancy is a strong science student, achieving better than 80% in grade seven and 77% in grade eight science. She is 13 years of age and shows confidence and self assuredness. She doesn't mind, nor is she afraid to ask questions in the large group classroom setting. She can talk to people without hesitation. She likes science and looks forward to it. She "tries hard and understands most everything." Nancy can answer most questions asked of her. She is bright, cheerful and capable.

Getting Help

He's a good teacher. Like if you need help or something, you just go to him and he'll explain it. He'll spend time on you when you want. He's nice. He'll say "If you want to come in for help, feel free to come and see me". After each experiment he goes through the questions and answers with us. This is good and helps the kids understand. He's the best science teacher in the school 'cause he explains things and you understand. He doesn't test you on things not taken in class. I get help if I don't understand something or if it's not clear to me.

Understanding

When my teacher explains things, that helps me understand. He lets us do most of the experiments and that helps you understand them. You see it happen better and remember it if you do it. This helps your understanding, too.

Being Interested

If he says something that interests you then, sometimes, I guess you'll think about it later. If it interests you then it's something you like and it means something to you. You learn new things all the time. Experiments are interesting to me; you're discovering something new. For example, we worked with rocks, checking for hardness by grouping them and finding what kind of rock each is.

Boring

We just watch him but sometimes we're bored. Well, see there, he's talking about the same question for a long time. He'll go over stuff and I'll understand it. But if he reviews then it's 'unmeaningful'. I already know it; it's in your mind. It's boring, too, if I did it in some other year. When you're bored you're not interested; you're thinking about something else. You look around the class at other students, the board, posters or the walls.

Being Wrong

You don't want to put anything down that's not correct or not right. If it's wrong you know it doesn't make sense.

Being Important

When something's important the tone of his voice changes and he says it louder. Like you hear what he says but if he says something that's important, you can hear the change of his voice. If it's important then it's meaningful to me and may be used later. It's special. I usually decide right away if something is important or not. If it's important you pay attention.

Liking Science

You're not doing the same things over like in language and math. You can do experiments and discover things yourself rather than having the teacher tell you what's going to happen. You can find out for yourself. My teacher's easy to understand - the way he puts things and emphasizes things that will be on tests.